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The status of *Senecio cambrensis* Rosser.

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Abstract

Senecio cambrensis Rosser is a hybrid of *Senecio vulgaris* L. (Common groundsel) (2n = 40) and *Senecio squalidus* L. (Oxford ragwort) (2n = 20). It is one of only five flowering plants known to have originated via allopolyploidy and to have become established in the wild. Two independent populations have formed, one in north Wales which was first recorded in 1948, and one in Edinburgh first recorded in 1974. The Edinburgh population is now considered to be extinct, not having been found there since 1993. Surveys carried out for the north Wales population in 1982-1984, 1987 and 2002-2004 have shown a decline in the number of sites and individuals. During 2010 and 2011 all known sites for *S. cambrensis* were visited and analysis was carried out to see if this decline has continued. In the past it was found in 4 main areas: Llanddulas on the north Wales coast, Alltami, Chirk, and in the areas surrounding Wrexham where it was first discovered. In 2010 and 2011 *S. cambrensis* was only found in the 3 areas of Llanddulas, Alltami, and Chirk. It was not recorded at Wrexham, and at the sites where it was still present, the area in which it was found had greatly reduced. The number of individuals had also greatly declined from peak numbers of 2226 in 1983 to just 168 in 2011. Analysis of the decline in the number of sites and individuals has shown that, following the IUCN Red List categories and criteria, *S. cambrensis* should be classed as Endangered, and, using the National rarity and scarcity assessment it should be classed as Nationally Rare. If no management is carried out for the species, it is very likely that it may follow the Edinburgh population and become extinct in the near future.

1. Introduction

1.1 *Senecio* hybrids

Since the introduction of the diploid Oxford ragwort, *Senecio squalidus* L. (2n = 20) from Sicily to Britain in the early 18th century, it has spread throughout the British Isles. Hybrids have occurred between *S. squalidus* and the native tetraploid *Senecio vulgaris* L. (2n = 40) (Abbott & Lowe, 2003). One such hybrid is the triploid *S. x baxteri* Druce (2n = 30) which is almost completely sterile. This hybrid is mostly found when parent species occur in large mixed populations (Abbott & Lowe, 2003). The first fertile hybrid was the radiate variant of *S. vulgaris, S. vulgaris var. hibernicus* Syme, which was first found in Oxford in 1832. It is now common in towns and areas of wasteland in many parts of the British Isles (Abbott & Lowe, 2003). *Senecio eboracensis* (2n = 40) another fertile hybrid was first recorded near York railway station by Abbot, R.J. and Marshall, D.F. in 1979. This species is not thought to be a first generation tetraploid hybrid of *S. vulgaris* and *S. squalidus* but a product of backcrossing (Abbott & Lowe, 2003).

Senecio cambrensis Rosser (2n = 60), is the hybrid of *Senecio vulgaris* L. *var vulgaris* (2n = 40) and *Senecio squalidus* L. (2n = 20) (Ingram & Noltie, 1995; Abbott & Ashton, 1992). It is one of only five flowering plants known to have originated via allopolyploidy and to have become established in the wild (Abbot & Lowe, 2004).

Both the parent species are very widespread in England, Wales and southern Scotland. Two populations of *S. cambrensis* have been formed, one in Leith, Edinburgh and another in north Wales. There is strong DNA evidence that these two populations have had two independent

origins (Abbott *et al,* 2007; Lowe & Abbott, 1996; Harris, Ingram, 1992). It was first recorded in north Wales at Cefn-y-Bedd, by H. E. Green in 1948 (Abbott & Ashton, 1992) and described from the wild by Rosser (1955) (Abbot & Forbes, 2002). It is thought that it had originated in north Wales sometime between 1910 and 1948. The Edinburgh population was first recorded in 1972 but is now considered extinct having not been recorded there since 1993.

S. cambrensis is an annual or short-lived perennial and can be up to 50cm high (Rosser, 1955). The leaves are deeply pinnately lobed with the lower leaves petiolate, and the upper leaves sessile (Stace, 1997). The inflorescence is leafy, at first as a dense corymb, but with longer flowering branches with pedicels elongating further when fruiting. There are four different morphs of *S. cambrensis*. The dominant morph is medium-rayed and the ligules are 4.0-7.5 mm. There is also a rayless, short rayed (ligules 2.0-3.5 mm) and long-rayed (8.0 – 11.0 mm) morph which usually accounts for about 5% of the population (Ingram, & Noltie, 1995; 1984).

S. cambrensis may be distinguished in the field from the similar looking *S. squalidus* and radiate *S. vulgaris* by the achene and involucral bract lengths, and pollen grain size can also be used. The species is self-compatible and reproduces mainly by self-fertilisation (Ingram & Noltie, 1995). Flowering begins in May and peaks in early June with a secondary peak in September and October.

The community exists as a series of sub-populations, or patches of variable size, which form in sites of repeated disturbance such as roadsides, pavements and deep disturbed soil in gardens (Ingram & Noltie, 1995). It also occurs in wall crevices which can act as a buffer against disturbances, which is where low numbers of individuals in Edinburgh managed to

survive for the last remaining years until it became extinct. It has been known for very large populations of the species to appear relatively quickly. At a site near Wrexham (Southsea tip) in July 1983, 104 individuals of *S. cambrensis* were present with no seedlings. In October 1983 there were only two mature individuals but >1000 seedlings (Ingram, & Noltie, 1995). By June 1984, 900 flowering individuals were recorded with hundreds of seedlings present.

1.2 Previous surveys

Along with many individual records there have been three main surveys of the north Wales population of *S. cambrensis.* These were carried out by Ingram and Noltie (1995) from 1982-1984, Morgan (unpublished 1987) (cited in Abbott *et al,* 2007) in 1987 and Abbott *et al* (2007) from 2002- 2004 (Appendix A).

In July 1982, 1983 and June 1984 Ingram and Noltie (1995) recorded *S. cambrensis* in the Wrexham area of north Wales. Over the three years it was recorded at 32 different sites (6 figure grid references) with 2121 individuals recorded in 1983. In 1987 Morgan (unpublished 1987) (cited in Abbott *et al,* 2007) revisited these sites in the Wrexham area and found 20 sites with *S. cambrensis* present and found a total of 557 individuals. Morgan (unpublished 1987) (cited in Abbott *et al,* 2007) also recorded 772 individuals of *S. cambrensis* in 6 new sites in the Mochdre, north Wales area. In June 2002, 2003 and 2004 Abbott *et al* (2007) revisited these known sites. In 2003 *S. cambrensis* was recorded at 6 sites in the Wrexham area with 400 individuals, and at 2 sites in the Mochdre area with 80 individuals.

During May, June and July in 2010 and May 2011 I revisited all known sites from previous surveys, and also from individual records, in order to record *S. cambrensis.* These surveys

were carried out to see whether the population is still present at these sites, and if so in what numbers.

1.3 Extinction in Scotland

S. cambrensis was first discovered in Edinburgh in 1982 where it is now known to have been present since at least 1974 (Abbott, Ingram & Noltie, 1983; Abbot & Forbes, 2002). The original sites and other potential sites were monitored each year from 1982 to 2001. The species was not found at any site after 1993 and so it was concluded that it had become extinct (Table 1) (Abbot & Forbes, 2002).

Table 1: Number of mature plants of *S.cambrensis* on sites in Leith, Edinburgh, from 1982 to 1994. X indicates sites that were completely re-developed during the period and were no longer available for colonisation (Data from Abbot & Forbes, 2002).

Sites	Date of survey (month/year)												
	Sep-82	Jun-83	Jun-84	Jun-85	Jun-86	Jun-87	Jun-88	Jun-89	Jun-90	May-91	Jun-92	Apr-93	Jun-94
Bangor Road	25	X	X	X	X	X	X	X	X	X	X	X	X
Sheriff Brae	43	19	5	2	0	0	0	0	0	0	0	0	0
Coal Hill (Factory)	4	2	0	0	1	1	0	0	0	0	0	0	0
Broad Wynd	19	2	1	X	X	X	X	X	X	X	X	X	X
Tolbooth Wynd	3	X	X	X	X	X	X	X	X	X	X	X	X
Salamander St	8	14	13	15	33	13	17	2	1	0	0	0	0
Coal Hill		23	20	23	22	15	9	3	3	2	2	3	0
Total	102	60	39	40	56	29	26	5	4	2	2	3	0

Like the north Wales population, *S. cambrensis* in Edinburgh grew on wasteland, roadsides, and in walls. When it was first discovered in 1982 it was recorded at 6 different sites which were all within 1.2 km of each other (Abbot & Forbes, 2002). 102 individuals were recorded, with three of the sites having 25, 43 and 19 individuals. Over time the sites became

overgrown by more competitive plants such as its parent plants, or the land was subject to development. Only Sheriff Brae had remained virtually undeveloped but it was eventually occupied entirely by its parent plants and other early colonisation species. The site Salamander St which had been wasteland was built on in 1989, leaving only the margins available for colonisation (Abbot & Forbes, 2002). The area of wasteland adjacent to Coal Hill was developed from 1988 onwards, while the river embankment became overgrown largely with *S. squalidus* (Abbot & Forbes, 2002). From when it was first discovered in 1982 the number of individuals of *S. cambrensis* steadily declined until 1993 when it was no longer found. This decline was in parallel with the decline in the number of available sites for colonisation.

1.4 *S. cambrensis* identification

The main source of recorder error when surveying *S. cambrensis* is misidentification. To determine whether an individual is *S. cambrensis* or radiate *S. vulgaris* requires close inspection of the achenes, involucral bract, and pollen grain sizes. It is not practical to carry this out in the field, and so voucher specimens need to be taken for analysis. *S. cambrensis* and radiate *S. vulgaris* occur in mixed populations and so it is difficult to identify all individuals in an area. During the surveys in 1982-1984 carried out by Ingram and Noltie, (1995) it was found that radiate *S. vulgaris* was present at 57% of the sites for *S. cambrensis*. On a number of occasions misidentification has been documented. For example a plant labelled '*S. vulgaris* – Giant radiate form' which had been cultivated from a plant found at Queensferry in 1948 was later determined as *S. cambrensis* by Leslie, A.C. in 1977 (Wynne, 1993). There may be high recorder error in the past where a few individual plants looked at have been identified as *S. cambrensis*, but the majority may have been radiate *S. vulgaris*, causing an overestimate of the population. This can also cause an underestimate of the

population if *S. cambrensis* is not detected. Taking a voucher specimen of each individual is not practical and may be detrimental to the population.

There are also conflicting opinions on the diagnostic features differentiating *S. cambrensis* and radiate *S. vulgaris* (Table 2).

Table 2. Differences in diagnostic features for *S. cambrensis* and radiate *S. vulgaris*. (Rosser, 1955; Stace, 1997; Abbott and Lowe, 2003; Rose, 2006)

	Achenes (mm)		Involucral bract (mm)	
	Senecio cambrensis	*Senecio vulgaris*	*Senecio cambrensis*	*Senecio vulgaris*
Rosser, E.M., 1955	3 - 3.5	< 2.5	–	–
Stace, C.A., 1998	>3	≤2.5	–	–
Abbott and Lowe, 2003	2.5 - 3.5	2.0 - 2.5	10 - 12	10 - 12
Rose, F. 2006	–	<3	–	8 - 10

If recorders in the past have used different sources of information for the identification of *S. cambrensis* this can be a large source of recorder error. Voucher specimens determined by an expert will reduce this.

1.5 Threats

The biggest threat to *S. cambrensis* is the nature of the habitat it colonises. It is a poor competitor and needs human interference as part of its ecology. It is this same human interference which possesses the greatest threat where activities such as highway maintenance can wipe out whole populations. There is a fine balance between too little disturbance where competition will take over, and too much disturbance which itself destroys *S. cambrensis*.

As *S. cambrensis* normally behaves like an annual, it is unable to compete and persist in the roadside grassland. It is more like the ruderal *S. vulgaris* than the perennial *S. squalidus* which can compete and persist for several years after disturbance (Ingram & Noltie, 1995).

Competition can be a particular problem for an allopolyploidy species if the parent plants have a higher number of offspring which will compete for open sites to colonise within dispersal range (Levin, 2000).

Another threat is its susceptibility to drought if the substrate is shallow. In July 1983 there were 942 flowering plants recorded at Ffrith with dense swards of seedlings growing in shallow substrate between a retaining wall and road surface (SJ287553) (Ingram & Noltie, 1995). By October 1983 almost all the seedlings had dried out and only 47 had flowered. This is a particular problem as it is mostly found in shallow soil of waste ground and roadsides. If there were to be a particularly dry period, this could have a detrimental effect on future populations.

The reduction in suitable sites for colonisation is also a threat to the *S. cambrensis* population. With the decline in industry and the increase in housing developments there has been a large reduction in the area of wasteland suitable for colonisation. Many past records of *S. cambrensis* made in the Wrexham area were on sites such as 'dumped rubble' and 'waste ground'. This type of site is becoming increasingly scarce.

There is a threat of disease which may affect the *S. cambrensis* population. In 2006 Whild, Dr S.J. and Lockton, Mr A.J. recorded an individual of *S. cambrensis* at Chirk (SJ28923943 7/5/2006) infected with the rust *Puccinia lagenophorae* Cooke. This fungal parasite is a common pathogen of *S. vulgaris* (Ingram & Noltie, 1995). In experimental studies, inoculating *S. vulgaris* with *Puccinia lagenophorae* caused loss of leaves, decreased shoot dry weight and high death rates in overwintering individuals (Paul & Ayres, 1986).

There has also been an increase in the use of herbicides to control weed populations particularly along roadsides and footpaths. This is highly detrimental to *S. cambrensis* at such sites (Abbott *et al*, 2007). The extent of the damage this could cause would depend on the time of year that it was sprayed and whether the seeds had been produced before spraying.

1.6 The importance of *S. cambrensis*

Due to its recent origin, and the fact that it can be re-synthesized experimentally, the plant is of considerable interest to science. It is also one of only five allopolyploidy flowering plants to have become established in the wild in recent times (Abbott & Lowe, 2004). New allopolyploid species are particularly interesting as their ecology and development can be monitored from an early stage.

S. cambrensis is endemic to the British Isles, and was classed as Near Threatened in the Vascular Plant Red Data List for Great Britain in 2005 (Cheffings *et al*, 2005). It was also classed as Nationally Rare in the National Rarity and Scarcity Assessment in 2006 (Cheffings, *et al* 2006).

1.7 IUCN Red List Categories and Criteria

One way to measure changes in the population over time and the risk of a species becoming extinct, is to use the IUCN Red List Categories and Criteria (IUCN, 2001). This system is widely understood and used for classifying species at a high risk of extinction. The criteria set out to categorise the extinction risk which can be applied to any taxonomic unit or species. The IUCN categories for the risk of extinction are Extinct (EX), Extinct in the wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). The IUCN definition of a species which has become extinct is:

> *'A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form'* (IUCN, 2001).

For a species to be categorised, there is a range of quantitative criteria. Each species is evaluated against all criteria but only one criterion needs to be met to qualify for a specific category. This is because not all criteria are appropriate for all taxon.

For each category there are 5 main criteria (A-E) (IUCN, 2001) (see Appendix B for detailed criteria): -

Criterion A

This looks at the percentage decline of a taxon in the recent past, or estimated for the future, which can be an observed, estimated, inferred or suspected decline. This can be measured by counts of sites, populations or individuals, area of occupancy (AOO) or extent of occurrence (EOO). It also looks at whether causes of the decline are clearly visible, whether they are understood, and whether they have ceased. Other factors which are used in this criterion include indices of abundance, declines in the quality of habitat, levels of exploitation, and the effects of introduced taxa.

Criterion B

This criterion is based on the geographic range of the species. This is used to identify threats due to extremely restricted distributions, combined with other risk factors (Cheffings, *et al*

2005). The geographic range can be measured either by extent of occurrence (EOO), or area of occupancy (AOO). Whether a population is severely fragmented or suffers extreme fluctuations is also taken into account.

Criteria C and D

These are based on the population size measured by the number of mature individuals present and the levels and pattern of decline.

Criterion E

This criterion uses quantitative analysis to estimate the extinction probability of the species.

Geographic range size and how it changes through time, is an important ecological characteristic of a species. It can be a good predictor of extinction risk, and can identify species which are narrowly distributed (Gaston & Fuller, 2009). There are a number of ways to measure geographic range, each with its own challenges.

Extent of occurrence (EOO)

Extent of occurrence (EOO), also known as species range, is a method of measuring geographic range which can be used for criteria A and B for the IUCN Red Data List. This method looks at the overall geographic spread of the localities at which the species occurs. It is thought that the larger the EOO, the less likely it is for all the localities to undergo simultaneous extinction (Gaston & Fuller, 2009). EOO is defined by the IUCN as 'the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy' (IUCN, 2001). This is often measured by the area within a

minimum convex polygon. This is the smallest polygon in which no internal angle exceeds 180 degrees and contains all the sites of occurrence (IUCN, 2001). The disadvantage of this method is that it assumes a homogenous species distribution and it can contain large areas of unsuitable habitat where the species is very unlikely to occur (Rondinini, *et al* 2006).

Area of occupancy (AOO)

The area of occupancy (AOO) is defined by the IUCN as 'the area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy' (IUCN, 2001). This method provides a more accurate picture of the population as, unlike the EOO, it only measures where the species actually occurs, and leaves out the areas which may be unsuitable habitat. This can determine how robust the distribution and the population sizes will be to threatening processes and the risk of extinction. The result of this measurement can depend greatly on the scale chosen. The standard method for measuring AOO set out by the IUCN is to use a 2 x 2 km grid overlay on a range map. This scale is not necessarily suitable for all species especially *S. cambrensis* as it may only occupy a fraction of a 1 x 1 km and is mostly found along linear habitats. Any scale above 3.2 x 3.2 km prevents categorisation as Critically Endangered as the result will exceed the $\leq$10 km^2 threshold.

Quantitative analysis

This is defined by the IUCN as 'any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options' (IUCN, 2001). One such technique which incorporates these factors is population viability analysis (PVA). Using models, PVA can try to predict the probability that a species will decline or become extinct in a certain period of time. There are many different PVA models which use factors such as demographic fluctuations,

environmental fluctuations, density dependence, observation errors and natural catastrophes to calculate the extinction risk (Ludwig, 1999). PVA is often used in conservation biology and in management decisions for species (Ludwig, 1999). Recently there have been doubts over the viability and usefulness of the results as they can vary greatly from the use of different PVA methods (Brook, 1999). It has been found that reliable predictions of long-term extinction probabilities are likely to require unattainable amounts of data (Fieberg & Ellner, 2000). Another problem is that the possible non-detection of surviving populations is usually not accounted for (Kery, *et al* 2006).

1.8 The Vascular Plant Red Data List for Great Britain

The Vascular Plant Red Data List for Great Britain (Cheffings, *et al* 2005) was created as part of the JNCC Species Status Assessment project to assess the status of the vascular plants throughout Great Britain. To create the list, the IUCN categories and criteria (2001) were used. Data used was mainly taken from comparisons between the New Atlas of the British and Irish Flora (Preston, *et al* 2002) and the Atlas of the British Flora (Perring & Walters, 1962). The results of these assessments are used to inform priorities in the Biodiversity Action Plan (BAP) process (Cheffings, *et al* 2005).

The IUCN does not include quantitative thresholds for the category Near Threatened. Cheffings, *et al* (2005) have provided a quantitative threshold for the category (Table 3).

Table 3. Thresholds for Near Threatened (Cheffings, *et al* 2005)

Criterion A	≥20% decline
Criterion B	≤30 locations and continuing decline
Criterion C	≤10000 individuals

Following this quantitative threshold for the category according to Cheffings, *et al* (2005) *S. cambrensis* was categorised as Near Threatened. It was categorised using criterion B which states that *S. cambrensis* was found in <30 locations (Cheffings & Farrell, 2006).

1.9 National Rarity and Scarcity Assessment

Another assessment system which is often used in Great Britain is the National Rarity and Scarcity Assessment. This assessment is based around the number of hectads in which a species is present. A Nationally Scarce species is defined as one which is found in 16 – 100 hectads in Great Britain and a Nationally Rare species is in 15 or fewer hectads. According to Cheffings, *et al* (2006) in 2006 *S. cambrensis* was classed as Nationally Rare.

2. Method

2.1 Data collection

To collect past records for *S. cambrensis*, a literature search was carried out. The paper by Abbott and Forbes (2002) provided detailed records from surveys of *S. cambrensis* in Leith, Edinburgh. For the north Wales region, papers from Ingram and Noltie (1995) and Abbott *et al* (2007) detailed their comprehensive surveys and results, and included a survey carried out by Morgan in 1987 (unpublished 1987) (cited in Abbott, *et al* 2007). Individual records for the north Wales area were provided by Lockton, A.J. from the Botanical Society of the British Isles, COFNOD (North Wales Environmental Information Service), and Ashton, P. A. from Edge Hill University. The published sources used were: The Flora of Flintshire: The flowering plants and Ferns of a north Wales county (Wynne, 1993) and The Rare Plants of Flintshire: a register of the rare, scarce or threatened plants in the old county of Flintshire (Wynne, *et al* 1998). Rich, T.C.G. of the Museum of Wales in Cardiff, also provided records from the herbarium sheets held there.

2.2 Field work

During May, June and July 2010 and May 2011 I revisited all known sites where *S. cambrensis* had been recorded. These months were chosen as this is the peak flowering time for the species. This was also the time when Ingram and Noltie (1995), Morgan (unpublished 1987) (cited in Abbott, *et al* 2007), and Abbott *et al* (2007) carried out their surveys. For each record made, an 8 figure grid reference, date, and the number of individuals found, was recorded and a comment made on its habitat and location. Because of its characteristic roadside habitat when surveying a 6 figure grid reference site, all roadsides within the grid reference were surveyed. From where the grid reference ended a further 100-200m of

roadside was surveyed, with the distance depending on whether *S. cambrensis* was present and the suitability of the habitat.

Voucher specimens and photographs were taken from each area for conformation. Specimens were only taken where there was a large number of healthy looking individuals. These were then confirmed by Rich, T.C.G from the National Museum of Wales where the specimens are now kept in the museum's herbarium. To determine the specimens, Rich, T.C.G mainly used the achene and involucral bract lengths and pollen grain sizes. He also compared them with an isotype specimen of *S. cambrensis* which is housed at the National Museum of Wales (Appendix C).

2.3 Data analysis

2.3.1 Species distribution

A distribution map of all records for *S. cambrensis* was created using Mapmate to show any patterns of distribution over time. This would clearly show areas where the species may have been lost or gained, if the species has moved over time, and where the core areas for the species are.

2.3.2 Number of new, lost and extant sites

A line graph was created to show the number of monads and 6 figure grid reference sites where the species has been lost or gained, and the number of extant sites over time. If the number of lost and new sites are both rising at the same rate this would show that the species is not in decline, and that it may be colonising new sites as fast as it is leaving others. If they are converging this could mean that the species is in decline.

2.3.3 Number of individuals

A scatter graph has also been used to show the change in the number of individuals recorded over time. The numbers of individuals were counted for the Ingram & Noltie (1995) surveys carried out in 1982-1984, the survey carried out by Morgan in 1987 (unpublished 1987) (cited in Abbott et al, 2003) and for the Abbott et al (2007) surveys carried out in 2002-2004. These were then compared with the number of individuals found in 2010 and 2011. The data from the surveys was used so that a fair comparison could be made. Date classes were not used as, for example, there were no full surveys carried out in the 1990s.

2.3.4 Percentage change in the number of individuals

A percentage change in the number of individuals was also calculated. This calculated the percentage change from the survey in 2002. This analysis is used for the IUCN categorisation in criterion A, which looks at the percentage population size reduction over the last 10 years.

2.3.5 Percentage of sites in 2010 re-found in 2011

As data has been collected for two years, analysis can be carried out to see what percentage of sites recorded in 2010 were re-found in 2011. This will measure the reliability of the re-visitation studies and how far away the plants can re-colonise over time.

2.3.6 Extent of occurrence

To analyse the data to be used in the IUCN Red List for criteria A and B, the extent of occurrence (EOO) was calculated. This was measured by a minimum convex polygon (convex hull) which is the shortest continuous imaginary boundary encompassing all known sites for *S. cambrensis* (IUCN, 2001). To calculate the EOO a convex polygon was first created by using Google Earth (Sampled red list index for plants, Sbachman, 2010). In

Google Earth a polygon was drawn around the boundaries of where *S. cambrensis* was found in the 1980s, 2000s and during the surveys of 2010 and 2011 combined, making sure no internal angle exceeded 180 degrees. The 1990s were not included as no fully comprehensive surveys were carried out in that period. These polygons were then exported to the software package GE Path (Sampled red list index for plants, Sbachman, 2010) which then calculated the area of the polygons in km^2.

2.3.7 Area of occupancy

To analyse the data to be used in the IUCN red list for criteria A and B, the area of occupancy (AOO) was also calculated. The standard scale recommended by the IUCN is a 2 x 2 km grid overlay on a range map and so the AOO would be :- AOO = occupied cells x 4 km^2 (IUCN, 2001).

The standard 2 x 2 km grid overlay is not appropriate for such small populations such as *S. cambrensis* and for linear habitats such as roadsides where it is found. In this case it would be more accurate to use the length of occupied roadside x road width. For each area where *S. cambrensis* was found the length of the occupied roadside measured in 1 km, and road width measured by 0.5km. Each area was then added to calculate the AOO. An AOO was then calculated for the 1980s, 2000s and the survey in 2011. Both the standard 2 x 2 km scale and the modified 1 x 0.5 km scale for *S. cambrensis* were used to see if there was a difference in the resulting IUCN category given.

2.3.8 National Rarity and Scarcity Assessment

For *S. cambrensis* to be categorised under the National Rarity and Scarcity Assessment the number of hectads where it was present during 1980 – 1989, 1990 – 1999, 2000 – 2009 and 2010/2011 was counted.

3. Results

3.1 Voucher specimens

The measurements made by Rich, T.C and Ahmed, Z. from the Museum of Wales, of the voucher specimens collected in 2011 of *S. cambrensis* and radiate *S. vulgaris*, varied from measurements stated by Rosser (1955) (Table 4).

Table 4. Comparison of diagnostic features for *S. cambrensis* and radiate *S. vulgaris* by Rosser (1955) and Rich, T.C. and Ahmed, Z. from the Museum of Wales, Cardiff.

	Rosser (1955)	Rich, T.C. and Ahmed, Z.
S. cambrensis		
Seed size (mm)	3 – 3.5	2.5 – 3.7 (mean 3.01)
Pollen Size (μm)	Mean 33.2, Range 30 - 36	Mean 35.44, Range 31 - 48.5
S. vulgaris		
Seed size (mm)	2 – 2.5	2.0 – 2.7 (Mean 2.36)
Pollen Size (μm)	Range 20 - 25	Mean 25.14, Range 25 – 27.5

Rich, T.C. and Ahmed, Z. found that although the mean seed size and involucral bract length are bigger for *S. cambrensis*, the ranges do overlap with those of radiate *S. vulgaris*. They found that *S. vulgaris* seemed to be more consistent than *S. cambrensis* in terms of its measurements. Most of the specimens from 2011 fitted well with one of the species descriptions, but there were a number of specimens where it was not so clear.

Two voucher specimens from the Wrexham area did not clearly fit the description for either species. Measurements made by Rich, T.C. and Ahmed, Z. are shown for voucher specimens from Pentre Broughton and Southsea.

Pentre Broughton, SJ30285349, 13/05/2011, Boyett, L.E.
Seed size: 2.2 mm
Mean pollen size: 39 µm

This was morphologically *S. vulgaris* but with large pollen.

Southsea, SJ30755149, 10/05/2011, Boyett, L.E.
Seed size: no seeds
Mean pollen size: 34.5 µm
Involucre length: 7.5 mm

Both these cases proved inconclusive but for this investigation both specimens were assumed to be *S. vulgaris.*

3.2 Species distribution

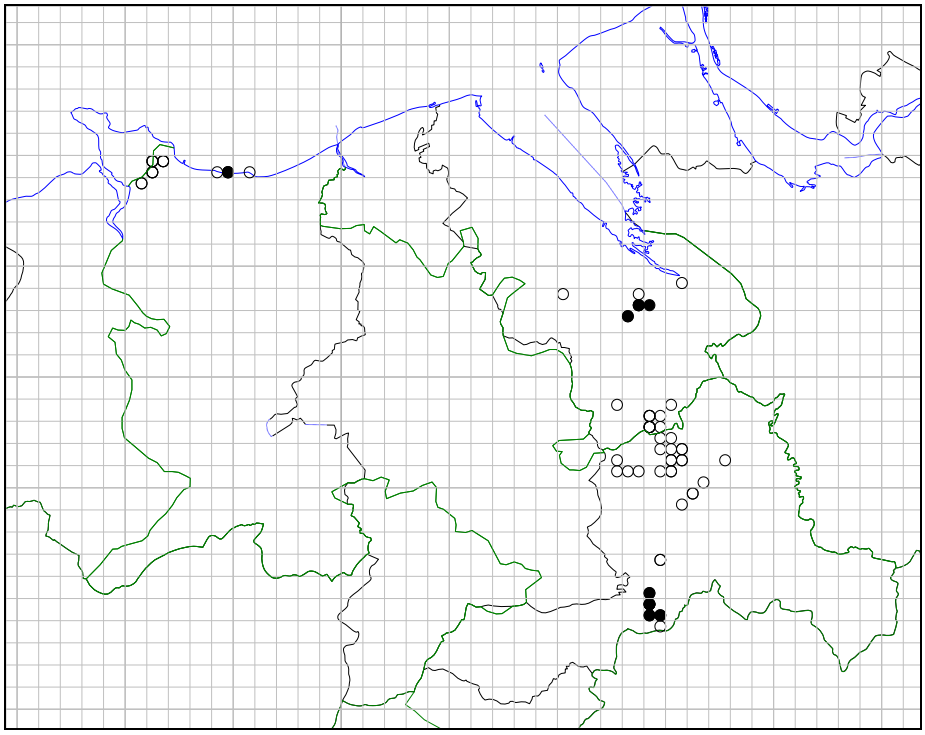

Figure 1: Distribution of *Senecio cambrensis* in North Wales (VC 50 and 51) (monads). Black dots are for current sites (2010/2011).

Figure 1: shows how the population distribution has changed over time. In 2010 and 2011 *S. cambrensis* was only found in 3 areas Alltami/New Brighton, Chirk/Pentre and Llanddulas. In the Wrexham area voucher specimens taken in 2010 were confirmed as *S. vulgaris* and specimens from 2011 were inconclusive.

3.3 Number of new, lost and extant sites

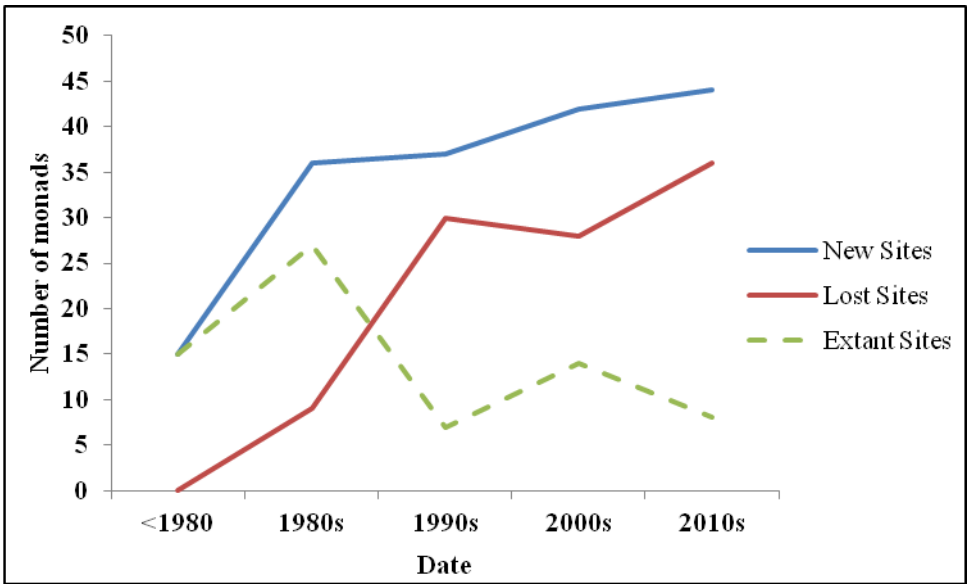

Figure 2: The number of new sites (monads) (top line) for *Senecio cambrensis* and the number of sites lost (lower line). The dotted line shows the number of extant sites at any point.

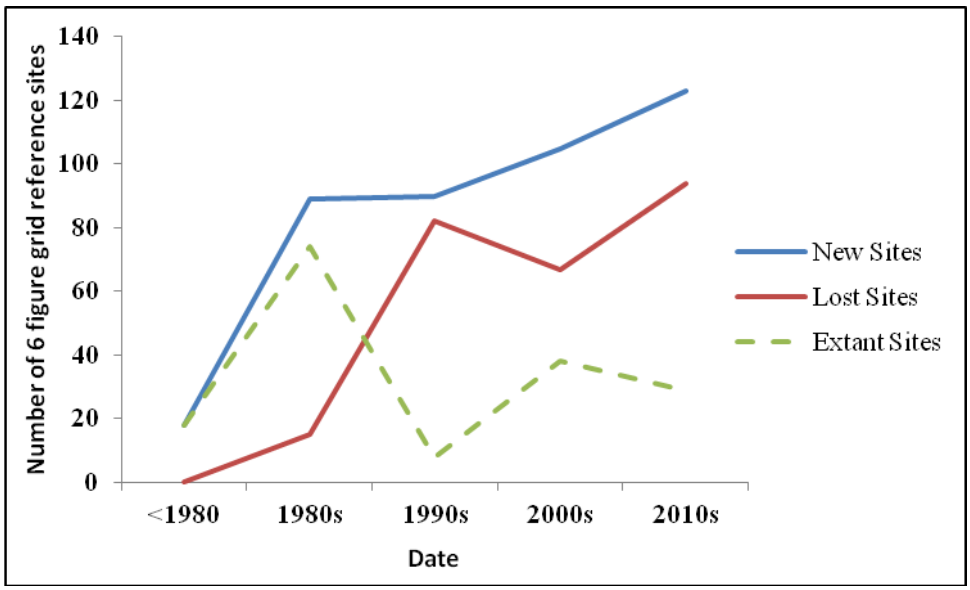

Figure 3: The number of new sites (6 figure grid reference) (top line) for *Senecio cambrensis* and the number of sites lost (lower line). The dotted line shows the number of extant sites at any point.

For both monad and 6 figure grid reference sites the number of extant sites peaked during the 1980's when the first full survey was carried out. Since then there was a large decline in the number of sites in the 1990's followed by a slight increase in the 2000s and then another decrease in 2010/2011. The number of new sites recorded since it was first discovered showed a sharp rise in the 1980's, and then has increased steadily to 2010/2011. The number of lost sites has followed the pattern of the new sites with a peak in the 1980s and a steady increase to 2010/2011. From the 2000s to 2010/2011 the number of new sites and lost sites are beginning to converge.

3.4 Number of individuals

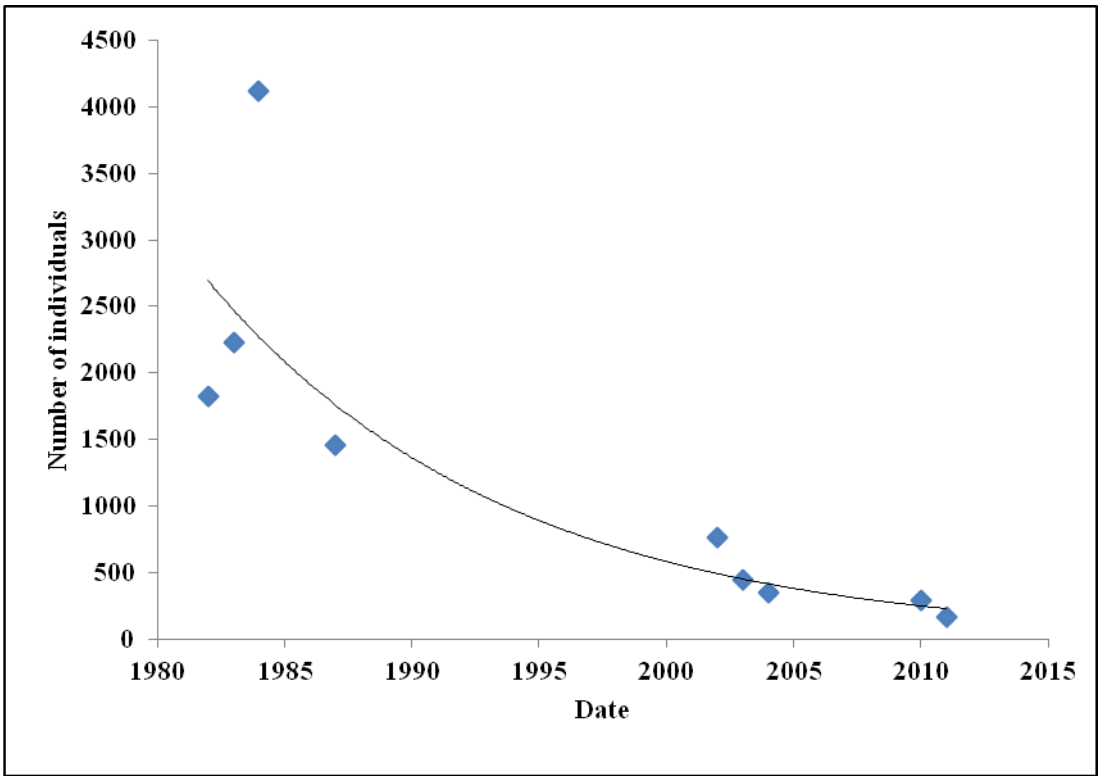

Figure 4: Number of *Senecio cambrensis* individuals found during the surveys carried out by Ingram & Noltie (1995) in 1982-1984, Morgan (unpublished 1987) (cited in Abbott *et al*, 2003) in 1987, Abbott *et al* (2007) in 2002-2004 and the surveys in 2010 and 2011.

Since the 1982-1984 surveys there has been a significant decline in the number of individuals (Figure 4). During the surveys in 1982-1984 the number of individuals varied greatly, almost doubling from 2226 individuals in 1983 to 4120 in 1984. Since 1987 when 1458 individuals were recorded there was a steady decline to 168 individuals in 2011. From 1984 to 2011 the rate of decline has decreased.

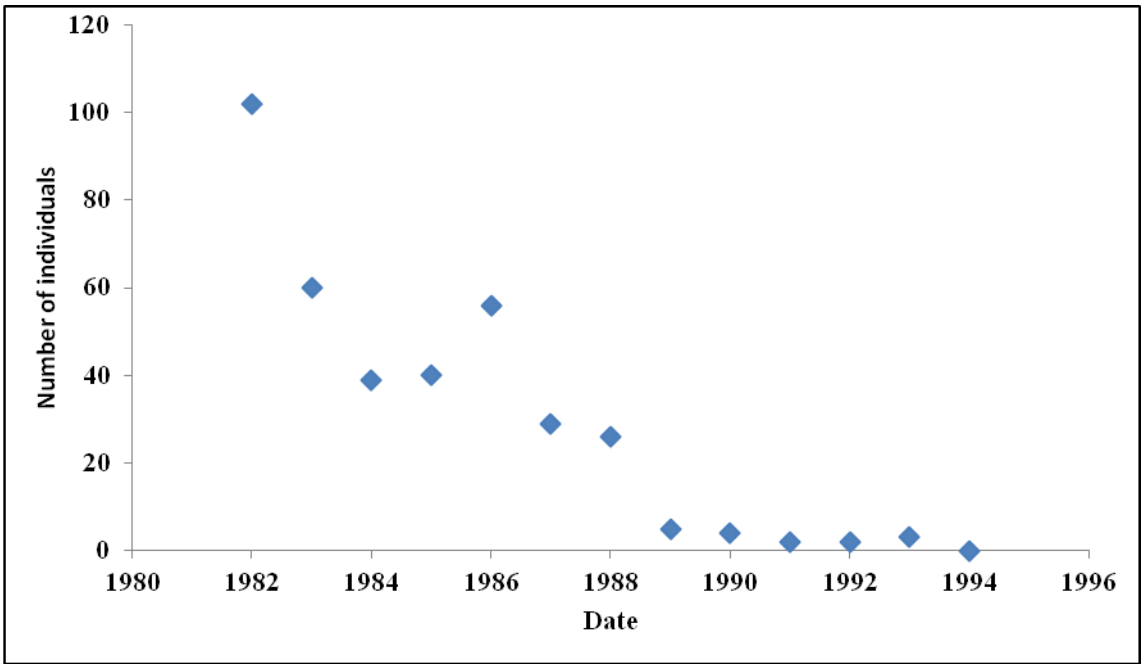

Figure 5: Number of mature *Senecio cambrensis* individuals recorded on sites in Leith, Edinburgh from 1982 – 1994 (Abbot & Forbes, 2002).

The decline in the number of individuals in Edinburgh from 1982 – 1994 (Figure 5) also shows a steep decline followed by a slower decline until the species was no longer recorded in 1994.

3.5 Percentage change in the number of individuals

There has been a 78% reduction in the number of individuals from 2002 (762 individuals) to 2011 (168 individuals recorded).

3.6 Percentage of sites in 2010 re-found in 2011

100% of monads, 52% of 6 figure grid reference sites and 21% of 8 figure grid reference sites where *S. cambrensis* were recorded in 2010 were re-found in 2011.

3.7 Extent of occurrence

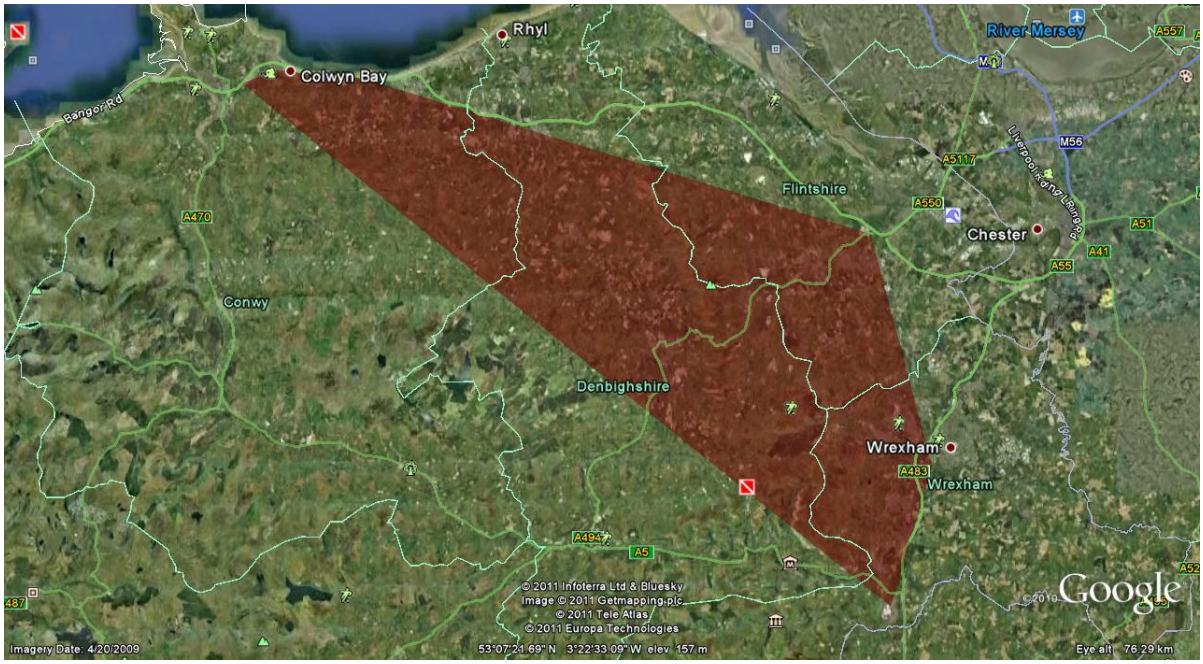

Figure 6: Area of convex polygon including all sites where *S. cambrensis* was recorded from 1980-1989.

The extent of occurrence for *S. cambrensis* recorded from 1980-1989 was 735 km^2 (Figure 6).

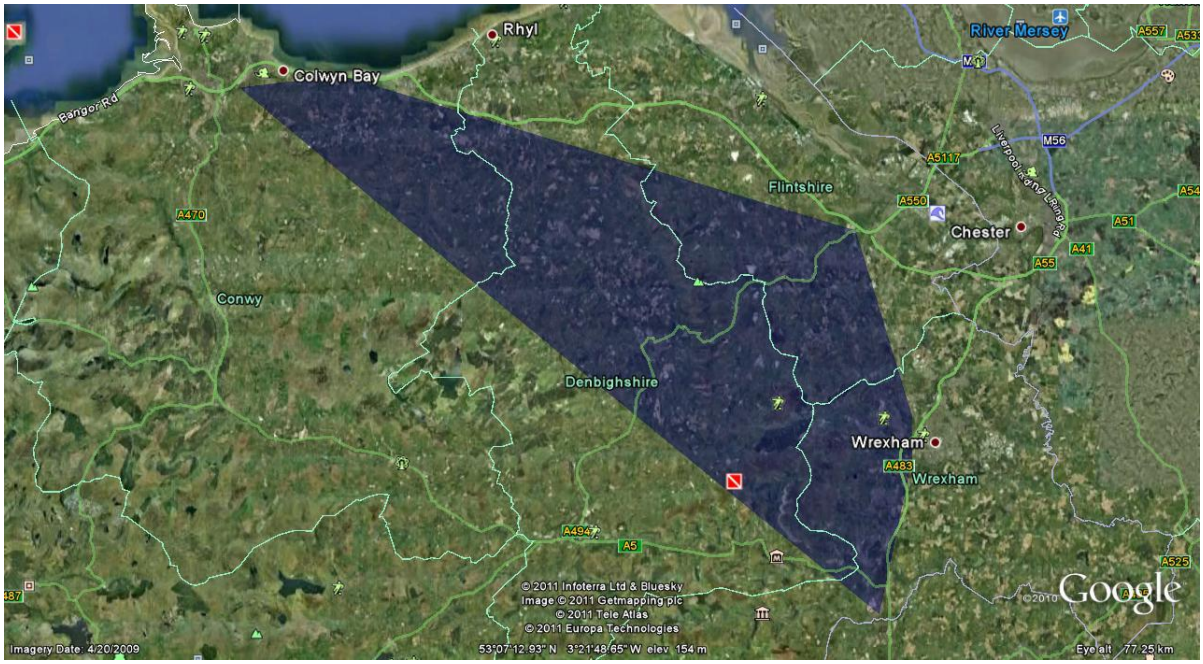

Figure 7: Area of convex polygon including all sites where *S. cambrensis* was recorded from 2000-2009.

The extent of occurrence for *S. cambrensis* recorded from 2000-2009 was 760 km^2 (Figure 7)

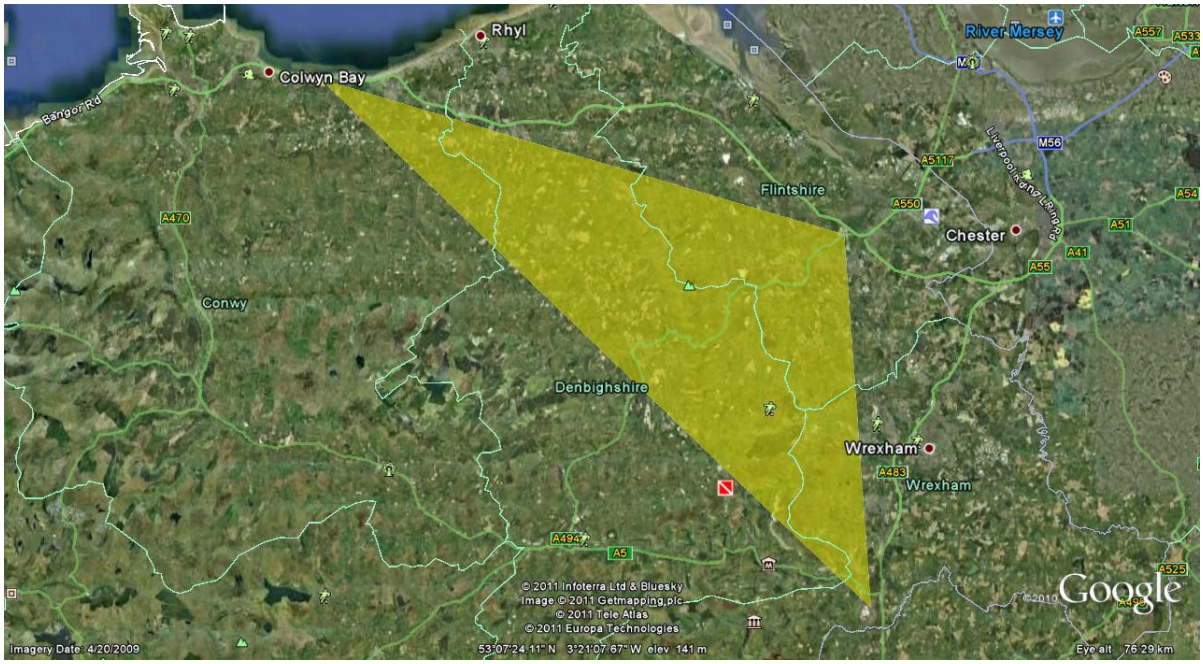

Figure 8: Area of convex polygon including all sites where *S. cambrensis* was recorded in 2010 and 2011.

The extent of occurrence for *S. cambrensis* recorded in 2011 was 521 km^2 (Figure 8)

3.8 Area of occupancy

Table 5: Area of occupancy of *S. cambrensis* measured using a 2 x 2 km grid overlay

Date	Area of occupancy (km^2)
1980-1989	40
2000-2009	32
2011	12

Table 6: Area of occupancy of *S. cambrensis* measured using a 1 x 0.5 km grid overlay

Date	Area of occupancy (km^2)
1980-1989	9
2000-2009	6
2011	3

When using both the 2 x 2 km and 1 x 0.5 km grid overlays the area of occupancy has declined over time (Table 5 and 6). The area calculated using the 1 x 0.5 km grid overlay is significantly less than the area calculated using the 2 x 2 km grid for each date range.

3.9 National Rarity and Scarcity Assessment

Table 7: Number of hectads *S. cambrensis* was recorded in during the 1980s, 2000s and in 2010/2011 with the resulting National Rarity and Scarcity Assessment category

	Number of hectads	National Rarity/Scarcity category
1980 - 1989	7	Nationally rare
2000 - 2009	7	Nationally rare
2010/2011	4	Nationally rare

The number of hectads where *S. cambrensis* was present has declined from 7 in the 1980s and 2000s to 4 hectads in 2010/2011. For each date range *S. cambrensis* was classed as Nationally Rare.

3.10 Survey observations

The typical habitat in which *S. cambrensis* was found was in shallow soil, and between walls and tarmac pavement along busy roads. In some cases the wall had a hedge on the top and individuals were found in and on top of the walls. In 2010, 13 plants recorded at Pentre (SJ2840) were found growing out from sandstone walls, but in 2011 there were no plants recorded growing out of walls. It was found in sites were there were little or no other species present and was often found with radiate and non-radiate *S. vulgaris*.

Some sites where *S. cambrensis* had previously been recorded but not in 2010/2011, had undergone development. Mochdre Commerce Park which was built in 2009 includes the Dolwyd and Ty-Gwyn, Mochdre sites where in 1987, Morgan, Ms V.M., recorded 326 individuals (SH818779). This new park consisted of many large buildings, landscaping and new paths within and outside the park. There were no individuals recorded at these sites during 2010 or 2011.

Figure 9: Mochdre Commerce Park built in 2009 on the site where *S. cambrensis* had previously been recorded.

The site at Gwersyllt, Wrexham (SJ311532) where in 1983 Ingram & Noltie recorded 70 individuals of *S. cambrensis* and was described as a ‘demolition site’ is now a housing estate with no *S. cambrensis* recorded.

Many of the roadsides where *S. cambrensis* has been recorded in the past and where it is still present in 2010/2011 showed signs of having been sprayed with herbicides. Some sites had no plants growing at all or if there were they were very frail and dying.

Figure 10: Possible herbicide damage to *S. cambrensis* at Pentre (Boyett, 23 June 2010, SJ285406)

In 2010, 26 individuals at the Alltami (SJ2766) and Alltami, Mold Road (SJ2866) sites had signs of disease on the leaves. It was a rusty colour which was similar to the description of the rust *Puccinia lagenophorae.* No individuals were found with the disease in 2011 and there was a marked decline in the number of individuals found.

Figure 11: *S. cambrensis* infected with disease at Alltami in 2010 (Boyett, 10 July 2010, SJ278662)

During the surveys in 2010 and 2011, in the Chirk area many of the road verges had communities of halophytic plants where you would expect *S. cambrensis* to occur suggesting that winter salting of the highways is also contributing to the decline of *S. cambrensis.*

4. Discussion

4.1 Is *Senecio cambrensis* declining?

The distribution map (Figure 1) shows that there are only three remaining areas where *S. cambrensis* is still present Alltami/New Brighton, Chirk/Pentre and Llanddulas. The numbers of sites within these three areas have greatly reduced from previous surveys. The three sites are also very isolated from each other which may contribute to the decline. In 2010/2011 *S. cambrensis* was not recorded in the Wrexham area, which had the largest populations in the past and which is where the species was first discovered.

The number of new sites found (monads and 6 figure grid reference sites) peaked during the first comprehensive surveys in the 1980s and then steadily increased to 2011. The number of sites lost during this time has also steadily increased. With new sites still being found and sites being lost at a similar rate this may be due to movement of the population. The sharp increase in sites lost in the 1990s and few new sites found is due to recorder effort as there were no comprehensive surveys carried out in this time period. Since the 2000s the rates in which new sites are being found and sites being lost are beginning to converge. There are more sites being lost than new sites being found. This is reflected in the significant decline in the number of extant sites from the 1980s to 2011.

Since 1982-1984 the overall number of individuals of *S. cambrensis* has declined dramatically, but since 2003 the rate of decline has slowed. This follows the same pattern that was seen in the decline of the Edinburgh population, which subsequently became extinct. The decrease in the rate of decline may be due to the last remaining populations occurring in relatively safe sites such as wall crevices and areas which avoid herbicide spraying. During

the 2011 survey no individuals were found in safe sites such as wall crevices, they were all recorded in shallow soil, on roadsides and in exposed positions prone to herbicide spraying. In Edinburgh in 1982 there were 102 individuals recorded taking 12 years to become extinct. At 168 individuals the north Wales population is very close to that of Edinburgh in 1982. If the north Wales population were to follow the same pattern of decline as Edinburgh it may not be long until it too becomes extinct.

The numbers of individuals varied greatly in the years 1982-1984, almost doubling from 2226 individuals in 1983 to 4120 in 1984. During the surveys in 2002-2004 and 2010-2011 with the populations significantly smaller the numbers did not fluctuate as much. This suggests that the decline is not likely to be due to natural fluctuations in the population.

In 2011 there were 168 individuals of *S. cambrensis* recorded. In the IUCN criteria for Critically Endangered, criterion C requires 'population size estimated to number fewer than 250 mature individuals'. Although the current population size is fewer than 250 individuals the population does not meet the other requirements of criterion C on population structure or extreme fluctuations (Criterion C, 2.a. and 2.b.) It does however come close to qualifying for the population structure requirement, which is for no subpopulation estimated to contain more than 50 mature individuals (Criterion C, 2.a.i). The largest subpopulation of *S. cambrensis* was 60 individuals at Alltami in 2011. The current population does however meet criterion C for the category Endangered. This requires there to be fewer than 2500 individuals and for no subpopulation to contain more than 250 mature individuals (Criterion C.2.a.i). The number of individuals also meets criterion D for the category Endangered which requires for there to be fewer than 250 mature individuals (Criterion D).

There has been a 78% decline in the number of individuals from 2002 – 2011. This meets Criterion A.2 for the IUCN Endangered category which requires there to be a population size reduction of ≥ 50% over 10 years and its reduction has not ceased. It has come very close to meeting Criterion A.2 for the Critically Endangered category which requires there to be a population size reduction of ≥ 80% over 10 years. From the survey in 2002 to 2011 it is only 9 years and so if the decline continues into 2012 it may then qualify as Critically Endangered.

The percentage of monads recorded in 2010 and re-found in 2011 was 100%, for 6 figure grid references 52%, and for 8 figure grid references 21%. With all the monads re-found in 2011, this shows that it is quite reliable to carry out re-visitation studies within the same monads each year. The relatively low percentage for 6 and 8 figure grid references re-found, reflects the ecology of the species. It likes to colonise bare patches of newly disturbed ground, which means it is unlikely that the species will continue to be found at the same site each year. This also shows how far the population can move and so there is a good possibility that there are populations which are yet to be discovered. These low percentages could also be due to the decline from 2010 to 2011 in the number of sites occupied.

The extent of occurrence initially increased from 735km^2 in the 1980s to 760km^2 in the 2000s. This is deceptive as 5 sites from 1980s were lost, but, as these fell in the middle of the convex polygon, this is not identified by the EOO. One site was gained in the 2000s (Chirk South), which increased the convex polygon size and so increased the EOO. In 2010/ 2011 the EOO decreased significantly to 521km^2 due to sites lost around the edges of the polygon. This decrease in the EOO does not reflect the many sites which have also been lost within the convex polygon during this time. The current EOO of 521km^2 does not qualify for Critically Endangered category in criterion B1. which requires the EOO to be less than 100km^2. It does

however qualify for Endangered, which requires the EOO to be less than 5000 km^2, for it to exist at no more than five locations and for there to be a continuing decline (Criterion B.1.a and b).

When using a 2 x 2 km grid overlay the standard IUCN method for measuring AOO, the AOO is seen to have reduced from 40 km^2 in the 1980s to 32 km^2 in the 2000s and to 12 km^2 in 2011. With an AOO of 12 km^2 it is close to Critically Endangered, which requires an AOO of 10 km^2 (Criterion B2). It does come under the Endangered category which requires the AOO to be less than 500 km^2. When using a 1 x 0.5 km grid overlay which is more suited to the ecology of *S. cambrensis*, the AOO was much lower. It declined from 9 km^2 in the 1980s to 6 km^2 in the 2000s to 3 km^2 in 2011. This is far lower than the 10 km^2 needed to be classed as Critically Endangered. The methodologies and guidelines for measuring AOO should be amended by IUCN to suit the ecologies of different species to prevent species like *S. cambrensis* from being wrongly categorised.

A Nationally Rare species according to the National rarity and scarcity assessment, must be found in 15 or fewer hectads. The number of hectads in which *S. cambrensis* is found has significantly declined from 7 in the 1980s and 2000s, to just 4 in 2010/2011, and so is still classed as a Nationally Rare species.

4.2 IUCN Red List categories

The current population recorded in May 2011, has qualified for the IUCN category Endangered by a number of criteria. It qualifies on the present number of individuals, and the decline in the number of individuals, EOO and its AOO. When using a non-standard scale for measuring the AOO, it has qualified for the Critically Endangered category.

4.3 Possible causes for decline and threats for the future

There are a number of possible factors which may have contributed to the decline of *S. cambrensis.* One possible reason why the species appears to have gone from the Wrexham area, is that the number of sites available for occupation has decreased considerably in and around the town. Until the mid 1980s, Wrexham and the surrounding area was a centre for coal mining and steel making. Following closure of these industries, many of these areas have now been replaced by large housing estates, causing a noticeable reduction of waste sites supporting weed populations**.** The decline in the number of individuals of *S. cambrensis* in the Leith area of Edinburgh, also followed a reduction in the waste sites and building plots on which *S. cambrensis* occurred. During the 2010/2011 surveys, the effect of this type of development was seen on a number of sites where there had been large populations in north Wales, and which have now gone. The building of Mochdre Commerce Park is likely to have contributed to *S. cambrensis* not being recorded at Dolwyd and Ty-Gwyn, Mochdre in 2010/2011 where up to 326 individuals had been recorded in the past. The increase in development is also evident as many records by Ingram & Noltie from 1982-1984 in the Wrexham area related to areas of mine spoil and dumped rubble most of which have now been re-developed.

The population in Edinburgh survived the last few years by living in cracks and wall crevices, which reduced the rate of extinction, and buffered against extreme fluctuations in conditions. As none of the North Wales populations found in 2011 were found in wall crevices, this will significantly increase the risk of extinction. As all the plants were found in shallow soil and were exposed, this leaves them at great risk of a catastrophic event wiping out a whole population.

The increase in the use of herbicides may well have contributed to the decline in the population of *S. cambrensis.* Many of the sites where it was once recorded are now void of any plants or have dying remains which suggests herbicides may be a cause. There would also be a problem if the verges were left alone, competition from other species would then be a threat.

In the Chirk area, where there has been a dramatic decline in the population, there are many halophytic plants on the road verge where you would expect *S. cambrensis* to occur. Salting of the roads during the winter may have changed the substrate, and so had a detrimental effect on the population. This could be experimentally tested to see if it could be a cause of the decline. *S. cambrensis* could be planted in a variety of soils with different levels of salt to assess the effect that it would have.

The disease, *Puccinia lagenophorae*, may have contributed to the decline in some of the *S. cambrensis* populations. It is known from experimental studies that the rust can cause decreased shoot dry weight and high death rates in the parent plant *S. vulgaris.* This rust is also known to infect *S. cambrensis*, as recorded by Whild, Dr S.J. and Lockton, at Chirk (SJ28923943 7/5/2006). The Alltami (SJ2766) and Alltami, Mold Road (SJ2866) populations in 2010 reached 251 individuals, 26 of which had visible signs of disease. In 2011 on the same sites only 98 individuals were recorded and these showed no signs of disease. There are other causes as to why this particular population declined, such as grass cutting, but the infection may well have contributed. This should be tested experimentally to see if the rust *Puccinia lagenophorae* has the same effect on *S. cambrensis* as it does on its parent plant *S. vulgaris.*

4.4 Problems with surveying *S. cambrensis*

S. cambrensis can be quite easily differentiated from *S. squalidus* and non-radiate *S. vulgaris*, but is much harder to distinguish it from the radiate form of *S. vulgaris.* The differences are hard to see in the field, especially early in the season when the seeds are not mature enough to measure. Even when specimens are examined in the laboratory, the features may not clearly fit either *S. cambrensis* or *S. vulgaris.* The findings by Rich, T.C and Ahmed, Z. which show that some of the size ranges for diagnostic features can overlap, are very significant. Previous recorders may not have accounted for this and misidentified the species. As the specimens from the Wrexham area were so variable, they could not be confirmed without further DNA analysis. This area should be re-surveyed in the future and more voucher specimens analysed to be certain that it is no longer there.

This difficulty in identification can cause recorder error when there are many individuals. *S. cambrensis* and radiate *S. vulgaris* can live in mixed populations, so some assumptions have to be made on the numbers present. If the voucher specimen and other individuals looked at in the field are identified as *S. cambrensis*, it might be assumed that the other individuals in the immediate area are also *S. cambrensis.* This could leave a big margin for error, as the specimens may only represent a few plants, and in fact the other individuals may be radiate *S. vulgaris*. Recorder error is likely to have occurred in past records which noted hundreds of individuals along a stretch of road between two grid references. It would not been practical to inspect each plant individually for accurate identification. This can also be a problem when there are not many individuals present, as the removal of a voucher specimen could have a detrimental effect on the population. There may have been significant recording error from misidentification of *S. cambrensis* in some past records, where the recorder may not have

been aware of the similarities to radiate *S. vulgaris*. In many cases voucher specimens were not collected and were not determined by an expert.

4.5 Problems with data analysis

In some past records, the sites for large populations have been recorded as extending from one grid reference to another, for example: 'Grid reference: SJ123456 – SJ123568'. This is difficult to analyse, as it is only certain that it was found in 2 different 6 figure grid reference sites, whereas it may have been present in all the 6 figure grid references in between. This can underestimate the size of the populations recorded.

As an annual, the number of *S. cambrensis* individuals can fluctuate greatly from year to year. Regular surveys of the population in the future would show the extent of these fluctuations and whether this is a cause for the apparent decline.

A further problem is that, as an annual, it does not necessarily appear in exactly the same place each year. It is important therefore to be aware that in re-visitation surveys that you cannot revisit the same site each year and expect the individuals to be in the same place. The only way to determine whether it has simply moved somewhere else, would be to survey all roads in the area, which is not always practical. In a few sites such as Brymbo (SJ2954), where *S. cambrensis* had been recorded in the past but not in 2010/2011, it was found further down the road at a different 6 figure grid reference site. It is not known whether this was a new site to which it had moved, or whether it had always been present and previous recorders had not looked there.

4.6 Recommended management for *S. cambrensis*

The organisations which are responsible for the management of roadsides where *S. cambrensis* is found must be made aware of its presence. The verges would still need management to stop more competitive species taking over but it must be carried out more sympathetically to accommodate *S. cambrensis.* The best management for it would be to create bare patches of ground along the road verge which the plant can colonise, and to avoid the use of herbicides in key areas. The first step should be to contact the ecological advisors to the relevant highway authorities.

4.7 Further work

Ideally all roads in the areas surrounding all known sites, and other potentially suitable sites, would be surveyed. This could find any unknown sites, and provide a base from which future surveys could be carried out. This would also give a clearer picture of population change, without the potential errors from unknown populations and recorder error. To survey surrounding areas and potential sites would not be practical in one survey. In the future, all roads in a randomly chosen area near to previous sites could be surveyed. After a number of years this would increase the confidence that there are no unknown sites.

Collection of extra information such as life history, demographic fluctuations, environmental fluctuations, density dependence, observation errors, and natural catastrophes, would mean that population viability analysis could be carried out to calculate the extinction risk. Although this may not be a particularly accurate method, it may help to measure the extinction risk and to put a timescale on the potential extinction.

To reduce identification errors recorders must get voucher specimens determined by an expert and be cautious when identifying large numbers of individuals.

5. Conclusion

Since 1948 when the first record of *S. cambrensis* was made in north Wales, the population peaked in the 1980s and has since seen a dramatic decline. During the surveys in 2010 and 2011 it was not recorded in its past core area to the north-east of Wrexham, and is now only found in 3 outlier populations in Chirk, Alltami and Llanddulas. The current population size and geographic range brings the species under the category of Endangered according to the IUCN Red List categories and criteria. If the population declines at the same rate it will not be long until it is classed as Critically Endangered. Under the National rarity and scarcity assessment *S. cambrensis* is classed as Nationally Rare. The causes of this decline may be due to the re-development of wasteland, increase in herbicide use, disease, and salting of the roads. Despite the clear decline in the population there are still many uncertainties. Further work is needed to survey areas around the sites where it now occurs, and also potential sites, in order to determine whether if there are any unknown populations. Further surveys are also needed in the Wrexham area to determine whether it has indeed gone from these sites.

6. Acknowledgements

I would like to thank Alex Lockton for his supervision, advice and provision of *Senecio cambrensis* records. Thank you also to Tim Rich for his advice and for determining my voucher specimens and to Paul Ashton for meeting with me to share his knowledge of the species. Finally a thank you to my family for all their support throughout.

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Appendix A

Historic and 2010/2011 survey records

Appendix A.
Table 1. *Senecio cambrensis* records from previous surveys.

Site	4 Figure Grid reference	8 Figure Grid reference	Date	Recorder	No	Comments
Llandudno Junction	SH7977		1979	Anon	1	Considered correct by COFNOD
Dolwyd	SH8177		May-87	Morgan, Ms V.M.,	326	
Dolwyd	SH8177		Jun-02	Abbott, Ireland and Rogers	40	
Dolwyd	SH8177		Jun-03	Abbott, Ireland and Rogers	65	
Dolwyd	SH8177		Jun-04	Abbott, Ireland and Rogers	22	
Ty Gwyn, Mochdre	SH8278		1966	Brummitt, Mr J.M.,		New roadside verge
Ty Gwyn, Mochdre	SH8278		1993	Green, Dr J.A.,		
Ty Gwyn, Mochdre	SH8278		27-May-87	Morgan, Ms V.M.,	220	Along roadside north of Ty Gwyn farm entrance, both sides of the road
Ty Gwyn, Mochdre	SH8278		28-May-86	Ashton, P.A. and Abbott, R.J.	28	
Mochdre	SH8279		1993	Green, Dr J.A.,		
Mochdre	SH8279		Jul-70	Brummitt, Mr J.M.,		Glan Y Wern Rd, Numerous plants at side of road and on parking ground nearby
Mochdre	SH8279		19-May-87	Morgan, Ms V.M.,	106	Along both sides of A55, in side roads and depots nearby
Mochdre	SH8279		1984	Noltie, Dr H.J.,	500	On embankment on north side of the road, sloping down to railway
Mochdre	SH8279		1984	Noltie, Dr H.J.,	250	South side of road
Mochdre	SH8279		1977	Pankhurst, Dr R.J.,	30	Partco Depot
Mochdre West	SH8379		1966	Brummitt, Mr J.M.,		Near A55, Tan-y-Bryn road junction
Mochdre West	SH8379		1979	Brummitt, Mr J.M.,		Tan-y-Bryn road bridge. Killed by spraying
Mochdre West	SH8379		1974	Fremlin, Prof J.H.,		
Mochdre West	SH8379		1993	Green, Dr J.A.,		Conway Road
Mochdre West	SH8379		1993	Green, Dr J.A.,		
Mochdre West	SH8379		27-May-87	Morgan, Ms V.M.,	1	By old A55 Conway road
Llanddulas West	SH8878		19-May-87	Morgan, Ms V.M.,	177	Both sides of A547 between Llanddulas + Old Colwyn, SH895782 to SH888783
Llanddulas West	SH8878		1984	Noltie, Dr H.J.,	1,500	Between Llanddulas and Colwyn Bay
Llanddulas West, Clobryn Rd	SH8978		19-May-87	Morgan, Ms V.M.,	2	Both sides of A547 between Llanddulas + Old Colwyn, SH895782 to SH888783
Llanddulas West, Clobryn Rd	SH8978		Jun-03	Abbott, Ireland and Rogers	15	
Llanddulas West, Clobryn Rd	SH8978		Jun-04	Abbott, Ireland and Rogers	18	
Llanddulas West, Clobryn Rd	SH8978		1987	Anon	1	Considered correct by COFNOD
Llanddulas East, A55	SH9178		1993	Green, Dr J.A.,		
Rhydymywn	SJ2067		1975	Newton, Mr A.L.,		
Minera West	SJ2551		04-Jun-87	Morgan, Ms V.M.,	7	On waste ground by the side of the road at Minera Quarry

Minera West	SJ2551		1987	Anon	1	Considered correct by COFNOD
Minera West Quarry	SJ2552		1975	Newton, Mr A.L.,	1	Near Minera Quarry
Ffrith Farm	SJ2557		1953	Green, Mr H.E.,	1	
Pentre Nr Minera	SJ2651		1981	Chater, Mr A.O.,	2	On roadside verge
New Brighton	SJ2665		Jun-03	Abbott, Ireland and Rogers	7	
New Brighton	SJ2665		Jun-04	Abbott, Ireland and Rogers	39	
Minera	SJ2751		1981	Chater, Mr A.O.,	94	Both sides of roads
Minera	SJ2751		1982	Noltie, Dr H.J.,	21	
Minera	SJ2751		Jul-82	R. Ingram & H.J. Noltie	7	Roadside
Minera	SJ2751		Jul-83	R. Ingram & H.J. Noltie	6	Roadside
Minera	SJ2751		Jun-84	R. Ingram & H.J. Noltie	8	Roadside
Minera	SJ2751		1987	Anon	1	Considered correct by COFNOD
Alltami	SJ2766		1986	Harmes, Mr P.,	40	On wasteland
Alltami	SJ2766		Jun-02	Abbott, Ireland and Rogers	36	
Alltami	SJ2766		Jun-03	Abbott, Ireland and Rogers	40	
Alltami	SJ2766		Jun-04	Abbott, Ireland and Rogers	32	
Alltami	SJ2766		27-Jun-03	Ireland, H. E.,	36	
Northop Hall	SJ2767		1980	Green, Dr J.A.,		
Chirk Kronospan Factory	SJ2838	SJ28983867	02-May-09	Lockton, Mr A.J.,	7	In 3 places, all under Leylandii hedges in the village
Chirk Kronospan Factory	SJ2838		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N. of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk Kronospan Factory	SJ2838		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N. of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk Kronospan Factory	SJ2838		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N. of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		1980	Benoit, Mr P.M.,		E. side of A5 near Halton/Black Park road junction SJ289395 - SJ288396
Chirk North	SJ2839		1980	Benoit, Mr P.M.,		E. side of A5 near Halton/Black Park road junction SJ289395 - SJ288396
Chirk North	SJ2839		13-May-80	Benoit, Mr P.M.,		Roadside, turning for Halton off the Holyhead Rd between Chirk and llangollen
Chirk North	SJ2839	SJ28943902	02-May-09	Lockton, Mr A.J.,	7	In 3 places, all under Leylandii hedges in the village
Chirk North	SJ2839	SJ28953901	02-May-09	Lockton, Mr A.J.,	7	In 3 places, all under Leylandii hedges in the village
Chirk North	SJ2839		22-May-87	Morgan, Ms V.M.,	2	Both sides of road between SJ289393 and SJ288397
Chirk North	SJ2839		22-May-87	Morgan, Ms V.M.,	128	Both sides of road between SJ289393 and SJ288397
Chirk North	SJ2839		22-May-87	Morgan, Ms V.M.,	2	Both sides of road between SJ289393 and SJ288397
Chirk North	SJ2839		1984	Noltie, Dr H.J.,		Big population
Chirk North	SJ2839		Aug-89	Perring, Dr F.H.,		
Chirk North	SJ2839		29-Jul-92	Perring, Dr F.H.,	100	Under a hedge on the east side of the old A5 north of Chirk
Chirk North	SJ2839		Jun-02	Abbott, Ireland and Rogers	200	
Chirk North	SJ2839		Jun-03	Abbott, Ireland and Rogers	109	
Chirk North	SJ2839		Jun-04	Abbott, Ireland and Rogers	123	

Chirk North	SJ2839		1986	Wainwright, Mrs M.,		Under roadside hedge + small colony on W.side of road,opp. original area nr lay-by
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		05-May-02	Whild, Dr S.J.,	100s	Freq along old A5 N of Chirk, roundabout SJ288397 - Kronospan factory SJ289387
Chirk North	SJ2839		29-Mar-03	Whild, Dr S.J.,	3	Many seedlings and a few plants already in flower along the east side of the old A5
Chirk North	SJ2839		02-Sep-03	Whild, Dr S.J.,		Still in flower
Chirk North	SJ2839		09-Dec-03	Whild, Dr S.J.,		Still in flower in December all along the roadside at Chirk
Chirk North	SJ2839	SJ28923943	07-May-06	Whild, Dr S.J.,		Frequent in a hedgerow near Chirk, with the rust Puccinia lagenophorae on the leaves
Pentre	SJ2840		Jun-04	Abbott, Ireland and Rogers	93	
Pentre	SJ2840		08-May-02	Whild, Dr S.J.,	6	Roadside + stonework of large embankment below rd between Pentre + Newbridge
Pentre	SJ2840		08-May-02	Whild, Dr S.J.,	1	By roadside
Pentre	SJ2840	SJ28664006	14-May-04	Whild, Dr S.J.,	1	Frequent along the A5 between Chirk and Llangollen
Pentre	SJ2840	SJ28624012	14-May-04	Whild, Dr S.J.,	1	Frequent along the A5 between Chirk and Llangollen
Pentre	SJ2840	SJ28574019	14-May-04	Whild, Dr S.J.,	1	Frequent along the A5 between Chirk and Llangollen
Pentre	SJ2840	SJ28554022	14-May-04	Whild, Dr S.J.,	1	Frequent along the A5 between Chirk and Llangollen
Pentre	SJ2840	SJ28494030	14-May-04	Whild, Dr S.J.,	1	Frequent along the A5 between Chirk and Llangollen
Ffrith	SJ2855		1961	Brummitt, Mr J.M.,	1	Limestone quarry 4 miles north-west of Ffrith
Ffrith	SJ2855		1954	Frost, Miss L.W.,	1	Crevices of a wall along a roadside near Ffrith
Ffrith	SJ2855		May-48	Green, Mr H.E.,		
Ffrith	SJ2855		1955	Green, Mr H.E.,		
Ffrith	SJ2855		May-87	Morgan, Ms V.M.,	1	
Ffrith	SJ2855		1987	Morgan, Ms V.M.,	19	On both sides of the road east of Ffrith between SJ287554 and SJ288553
Ffrith	SJ2855		1987	Morgan, Ms V.M.,	1	On both sides of the road east of Ffrith between SJ287554 and SJ288553
Ffrith	SJ2855		1984	Noltie, Dr H.J.,	2	Big population
Ffrith	SJ2855		Jul-82	R. Ingram & H.J. Noltie	486	Roadside both sides
Ffrith	SJ2855		Jul-83	R. Ingram & H.J. Noltie	942	
Ffrith	SJ2855		Jun-84	R. Ingram & H.J. Noltie	13	
Ffrith	SJ2855		Jun-04	Abbott, Ireland and Rogers	1	
Ffrith	SJ2855		Apr-52	Gordon, V.,	1	
Ffrith	SJ2855		Dec-54	Gordon, V.,	1	

Ffrith	SJ2855		Oct-55	Gordon, V.,	1	
Ffrith	SJ2855		1954	Rosser, Dr E.M.,		
Ffrith	SJ2855		1956	Rosser, Dr E.M.,		
Ffrith	SJ2855		1967	Sumner, Ms A.,		
Ffrith	SJ2855		1994	Wynne, Dr G.,		
Ffrith	SJ2855		12-Jul-82	Wynne, Dr G.,	1	Roadside, base of wall
Ffrith	SJ2855		03-Oct-86	Ashton, P.A. and Abbott, R.J.	25	
Llanfynydd	SJ2856		1987	Morgan, Ms V.M.,	4	On roadside of the B5101 near Coed Issa Farm
Llanfynydd	SJ2856		1982	Noltie, Dr H.J.,	109	On edge of tarmac pavement
Llanfynydd	SJ2856		Jul-82	R. Ingram & H.J. Noltie	100	
Llanfynydd	SJ2856		Jul-83	R. Ingram & H.J. Noltie	29	
Llanfynydd	SJ2856		Jun-84	R. Ingram & H.J. Noltie	50	
Llanfynydd	SJ2856		1975	Wynne, Dr G.,		
Llanfynydd	SJ2856		1994	Wynne, Dr G.,		
Llanfynydd	SJ2856		Jul-82	Noltie, Dr H.J.,	1	In tarmac on pavement opposite school
Llanfynydd	SJ2856		23-Apr-76	Wynne, Dr G.,		
Chirk South	SJ2937	SJ29053787	07-May-06	Whild, Dr S.J.,		
Chirk	SJ2938	SJ29053812	07-May-06	Whild, Dr S.J.,		
Ruabon	SJ2943		May-87	Morgan, Ms V.M.,	4	
Ruabon	SJ2943		12-Jun-87	Morgan, Ms V.M.,	4	In two patches on the side of Plas Bennion Road
Ruabon	SJ2943		1982	Noltie, Dr H.J.,	50	On hard recently disturbed soil along 100m of roadside near Ruabon
Ruabon	SJ2943		Jul-83	R. Ingram & H.J. Noltie	27	
Ruabon	SJ2943		Jun-84	R. Ingram & H.J. Noltie	69	
Ruabon	SJ2943		Jun-03	Abbott, Ireland and Rogers	1	
Ruabon	SJ2943		08-May-02	Whild, Dr S.J.,	2	On verge of Plas Bennion Road
Southsea West	SJ2951		1982	Noltie, Dr H.J.,	1	Mine spoil
Southsea West	SJ2951		Jul-82	R. Ingram & H.J. Noltie	37	Mine spoil
Southsea West	SJ2951		Jul-83	R. Ingram & H.J. Noltie	104	Mine spoil
Southsea West	SJ2951		Jun-84	R. Ingram & H.J. Noltie	900	Mine spoil
Brymbo South	SJ2953		Jul-82	R. Ingram & H.J. Noltie	10	
Brymbo South	SJ2953		Jul-83	R. Ingram & H.J. Noltie	7	
Brymbo South	SJ2953		Jul-82	R. Ingram & H.J. Noltie	2	Garden
Brymbo South	SJ2953		Jul-83	R. Ingram & H.J. Noltie	25	Garden
Brymbo South	SJ2953		Jun-84	R. Ingram & H.J. Noltie	6	Garden
Brymbo South	SJ2953		Jul-82	R. Ingram & H.J. Noltie	3	Roadside
Brymbo South	SJ2953		Jun-84	R. Ingram & H.J. Noltie	1	Roadside

Brymbo South	SJ2953		1985	Noltie, Dr H.J.,		
Brymbo South	SJ2953		1985	Noltie, Dr H.J.,		
Brymbo South	SJ2953		03-Jun-87	Morgan, Ms V.M.,	16	In car park of the English Methodist Chaple
Brymbo South	SJ2953		30-May-87	Ashton, P.A. and Abbott, R.J.	20	
Brymbo	SJ2954		Jul-82	R. Ingram & H.J. Noltie	6	Rubble in garden
Brymbo	SJ2954		Jul-83	R. Ingram & H.J. Noltie	50	Rubble in garden
Brymbo	SJ2954		Jun-84	R. Ingram & H.J. Noltie	7	Rubble in garden
Brymbo	SJ2954		Jul-82	R. Ingram & H.J. Noltie	1	Roadside
Brymbo	SJ2954		Jul-83	R. Ingram & H.J. Noltie	2	Roadside
Brymbo	SJ2954		Jun-84	R. Ingram & H.J. Noltie	8	Roadside
Brymbo	SJ2954		1984	Rumsey, Dr F.J.,	1	By the B5102 between Ffrith and Cefn-y-Bedd by roadside wall and bank
Cymau South	SJ2955		1975	Wallace, I.D.,		
Cymau	SJ2956		Jul-82	R. Ingram & H.J. Noltie	5	Roadside and grassy ditch
Cymau	SJ2956		Jul-83	R. Ingram & H.J. Noltie	3	
Cymau	SJ2956		Jun-84	R. Ingram & H.J. Noltie	3	
Cymau	SJ2956		1982	Noltie, Dr H.J.,	1	Considered correct by COFNOD
Southsea	SJ3051		Jul-82	R. Ingram & H.J. Noltie	37	
Southsea	SJ3051		Jul-83	R. Ingram & H.J. Noltie	129	
Southsea	SJ3051		Jun-84	R. Ingram & H.J. Noltie	21	
Southsea	SJ3051		Jul-82	R. Ingram & H.J. Noltie	8	
Southsea	SJ3051		Jul-82	R. Ingram & H.J. Noltie	42	
Southsea	SJ3051		Jul-83	R. Ingram & H.J. Noltie	132	
Southsea	SJ3051		Jun-84	R. Ingram & H.J. Noltie	26	
Southsea	SJ3051		May-87	Morgan, Ms V.M.,	94	
Southsea	SJ3051		Jun-02	Abbott, Ireland and Rogers	12	
Southsea	SJ3051		Jun-03	Abbott, Ireland and Rogers	50	
Southsea	SJ3051		Jun-04	Abbott, Ireland and Rogers	4	
Southsea	SJ3051		1982	Noltie, Dr H.J.,		On a roadside
Southsea	SJ3051		1982	Noltie, Dr H.J.,		On waste ground
Southsea	SJ3051		04-Jun-87	Morgan, Ms V.M.,	94	NW side of the B5430, and at the junction with Smithy Road.
Southsea	SJ3051	SJ30785149	23-May-03	Whild, Dr S.J.,		Frequent along a roadside in New Broughton from SJ30785149 to SJ30845145
Southsea	SJ3051	SJ30845145	23-May-03	Whild, Dr S.J.,		Frequent along a roadside in New Broughton from SJ30785149 to SJ30845145
Southsea	SJ3051		1987	Anon	1	Considered correct by COFNOD
Southsea	SJ3051		30-May-87	Ashton, P.A. and Abbott, R.J.	40	
Brynteg	SJ3052		Jul-82	R. Ingram & H.J. Noltie	3	
Brynteg	SJ3052		Jul-82	R. Ingram & H.J. Noltie	2	Dumped rubble

Brynteg	SJ3052	Jul-83	R. Ingram & H.J. Noltie	11	Dumped rubble
Brynteg	SJ3052	Jun-84	R. Ingram & H.J. Noltie	41	Dumped rubble
Brynteg	SJ3052	Jul-82	R. Ingram & H.J. Noltie	42	Roadside
Brynteg	SJ3052	Jul-83	R. Ingram & H.J. Noltie	4	Roadside
Brynteg	SJ3052	Jun-84	R. Ingram & H.J. Noltie	1	Roadside
Brynteg	SJ3052	Jul-82	R. Ingram & H.J. Noltie	60	
Brynteg	SJ3052	Jul-83	R. Ingram & H.J. Noltie	88	
Brynteg	SJ3052	Jun-84	R. Ingram & H.J. Noltie	45	
Brynteg	SJ3052	Jul-82	R. Ingram & H.J. Noltie	26	
Brynteg	SJ3052	Jul-83	R. Ingram & H.J. Noltie	3	
Brynteg	SJ3052	Jun-84	R. Ingram & H.J. Noltie	25	
Brynteg	SJ3052	Jul-82	R. Ingram & H.J. Noltie	22	
Brynteg	SJ3052	Jul-83	R. Ingram & H.J. Noltie	9	
Brynteg	SJ3052	Jun-84	R. Ingram & H.J. Noltie	11	
Brynteg	SJ3052	Jul-82	R. Ingram & H.J. Noltie	9	
Brynteg	SJ3052	Jul-83	R. Ingram & H.J. Noltie	3	
Brynteg	SJ3052	1982	Noltie, Dr H.J.,		
Brynteg	SJ3052	1985	Noltie, Dr H.J.,		Brynteg school
Brynteg	SJ3052	1985	Noltie, Dr H.J.,		Cefn
Brynteg	SJ3052	1985	Noltie, Dr H.J.,		Cefn
Brynteg	SJ3052	1985	Noltie, Dr H.J.,		High Street and Westminster Road, Brynteg
Pentre Broughton	SJ3053	03-Jun-87	Morgan, Ms V.M.,	46	Along pavments, roadsides + hedges, esp. Westminster Rd SJ308530-SJ310520
Pentre Broughton	SJ3053	1982	Noltie, Dr H.J.,		Pisgah Hill, Cefn
Pentre Broughton	SJ3053	1982	Noltie, Dr H.J.,		Pentre Broughton
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	3	
Pentre Broughton	SJ3053	Jul-83	R. Ingram & H.J. Noltie	7	
Pentre Broughton	SJ3053	Jun-84	R. Ingram & H.J. Noltie	2	
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	2	
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	37	
Pentre Broughton	SJ3053	Jul-84	R. Ingram & H.J. Noltie	4	
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	11	
Pentre Broughton	SJ3053	Jul-84	R. Ingram & H.J. Noltie	1	
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	29	
Pentre Broughton	SJ3053	Jul-83	R. Ingram & H.J. Noltie	8	
Pentre Broughton	SJ3053	Jun-84	R. Ingram & H.J. Noltie	6	
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	40	Roadside and dumped rubble

Pentre Broughton	SJ3053	Jul-83	R. Ingram & H.J. Noltie	17	Roadside and dumped rubble
Pentre Broughton	SJ3053	Jun-84	R. Ingram & H.J. Noltie	1	Roadside and dumped rubble
Pentre Broughton	SJ3053	Jul-82	R. Ingram & H.J. Noltie	1	
Pentre Broughton	SJ3053	1987	Anon	1	Considered correct by COFNOD
Ffos-y-go	SJ3054	04-Jun-87	Morgan, Ms V.M.,	14	In two places on the north roadside verge at Ffos-y-go/Windy Hill.
Ffos-y-go	SJ3054	1982	Noltie, Dr H.J.,		Windy Hill
Ffos-y-go	SJ3054	1982	Noltie, Dr H.J.,		Roadside and dumped rubble
Ffos-y-go	SJ3054	1982	Noltie, Dr H.J.,		Roadside and dumped rubble
Ffos-y-go	SJ3054	Jul-82	R. Ingram & H.J. Noltie	40	
Ffos-y-go	SJ3054	Jul-83	R. Ingram & H.J. Noltie	6	
Ffos-y-go	SJ3054	Jul-82	R. Ingram & H.J. Noltie	4	
Ffos-y-go	SJ3054	Jul-83	R. Ingram & H.J. Noltie	14	
Ffos-y-go	SJ3054	1987	Anon	1	Considered correct by COFNOD
Caergwrle	SJ3057	1955	Frost, Miss L.W.,	1	In quantity, roadside near Caergwle
Rhostyllen	SJ3148	Jul-82	R. Ingram & H.J. Noltie	365	365 plants from SJ317487 - SJ324493
Rhostyllen	SJ3148	Jul-83	R. Ingram & H.J. Noltie	110	110 plants from SJ317487 - SJ324493
Rhostyllen	SJ3148	Jun-84	R. Ingram & H.J. Noltie	575	575 plants from SJ317487 - SJ324493
Stansty Park/ Pool Mouth	SJ3152	May-87	Morgan, Ms V.M.,	1	
Stansty Park/ Pool Mouth	SJ3152	03-Jun-87	Morgan, Ms V.M.,	46	Pavments, roadsides + hedges, esp. Westminster Rd between SJ308530, SJ310520
Stansty Park/ Pool Mouth	SJ3152	Jul-82	R. Ingram & H.J. Noltie	163	
Stansty Park/ Pool Mouth	SJ3152	Jul-83	R. Ingram & H.J. Noltie	419	
Stansty Park/ Pool Mouth	SJ3152	Jun-84	R. Ingram & H.J. Noltie	29	
Stansty Park/ Pool Mouth	SJ3152	Jun-02	Abbott, Ireland and Rogers	5	
Gwersyllt	SJ3153	1957	Jones, E.P.A.,		
Gwersyllt	SJ3153	04-Jun-87	Morgan, Ms V.M.,	5	On west side of Summerhill Road
Gwersyllt	SJ3153	1982	Noltie, Dr H.J.,		Demolition site
Gwersyllt	SJ3153	Jul-82	R. Ingram & H.J. Noltie	24	
Gwersyllt	SJ3153	Jul-83	R. Ingram & H.J. Noltie	70	
Gwersyllt	SJ3153	Jun-84	R. Ingram & H.J. Noltie	12	
Queensferry	SJ3168	1948	Jones, E.P.A.,	1	
Rhostyllen east	SJ3249	13-May-87	Morgan, Ms V.M.,	1	50, On NW. side of the A483 N. of Rhosyllen, between SJ321490-SJ322492
Rhostyllen east	SJ3249	13-May-87	Morgan, Ms V.M.,	50	50, On NW. side of the A483 N. of Rhosyllen, between SJ321490-SJ322492
Rhostyllen east	SJ3249	Jul-82	R. Ingram & H.J. Noltie	1	365 plants from SJ317487 - SJ324493
Rhostyllen east	SJ3249	Jul-83	R. Ingram & H.J. Noltie	1	110 plants from SJ317487 - SJ324493
Rhostyllen east	SJ3249	Jun-84	R. Ingram & H.J. Noltie	1	575 plants from SJ317487 - SJ324493
Rhostyllen east	SJ3249	Jun-02	Abbott, Ireland and Rogers	37	

Rhostyllen east	SJ3249		Jun-03	Abbott, Ireland and Rogers	113	
Rhostyllen east	SJ3249		Jun-04	Abbott, Ireland and Rogers	17	
Rhostyllen east	SJ3249	SJ32314925	08-May-02	Whild, Dr S.J.,	3	On a sandstone wall topped by a hedge
Rhostyllen east	SJ3249		08-May-02	Whild, Dr S.J.,	10	Along roadside
Rhostyllen east	SJ3249		30-May-87	Ashton, P.A. and Abbott, R.J.	21	
Wrexham, Trading estate	SJ3350		1968	Gillison, M.,		Wrexham trading estate
Wrexham	SJ3552		1970	Brummitt, Mr J.M.,	2	

Appendix A.

Table 2. *Senecio cambrensis* records from the 2010 and 2011 surveys.

Site	4 Figure Grid reference	8 Figure Grid reference	Date	Recorder	No	Comments
Llanddulas West, Clobryn Road	SH8978	SH89377826	05-May-11	Boyett, L. E.	5	N. side of A547, between tarmac pavement and wooden fence
Llanddulas West, Clobryn Road	SH8978	SH89367826	05-May-11	Boyett, L. E.	1	N. side of A547, between tarmac pavement and wooden fence
Llanddulas West, Clobryn Road	SH8978	SH89357825	05-May-11	Boyett, L. E.	5	N. side of A547, between tarmac pavement and wooden fence. Voucher specimen
Llanddulas West, Clobryn Road	SH8978	SH89417825	05-May-11	Boyett, L. E.	8	N. side of A547, between tarmac pavement and wooden fence
New Brighton	SJ2665	SJ26316546	22-Jul-10	Boyett, L. E.	2	S. facing, grass verge between tarmac pavement and hawthrone hedge
New Brighton	SJ2665	SJ26326546	22-Jul-10	Boyett, L. E.	3	S. facing, grass verge between tarmac pavement and hawthrone hedge
New Brighton	SJ2665	SJ26366546	22-Jul-10	Boyett, L. E.	1	S. facing, grass verge between tarmac pavement and hawthrone hedge
New Brighton	SJ2665	SJ26396547	22-Jul-10	Boyett, L. E.	1	S. facing, grass verge between tarmac pavement and hawthrone hedge
New Brighton	SJ2665	SJ26506550	22-Jul-10	Boyett, L. E.	1	S. facing, grass verge between tarmac pavement and hawthrone hedge
New Brighton	SJ2665	SJ26576552	22-Jul-10	Boyett, L. E.	1	S. facing, grass verge between tarmac pavement and hawthrone hedge
New Brighton	SJ2664	SJ26316545	16-May-11	Boyett, L. E.	13	N. side of A494, between tarmac pavement and hedge in shallow soil. Voucher specimen
New Brighton	SJ2665	SJ26286545	16-May-11	Boyett, L. E.	3	N. side of A494, between tarmac pavement and hedge in shallow soil. Voucher specimen
New Brighton	SJ2665	SJ26316546	16-May-11	Boyett, L. E.	8	N. side of A494, between tarmac pavement and hedge in shallow soil
New Brighton	SJ2665	SJ26326546	16-May-11	Boyett, L. E.	2	N. side of A494, between tarmac pavement and hedge in shallow soil
New Brighton	SJ2665	SJ26306545	16-May-11	Boyett, L. E.	1	N. side of A494, between tarmac pavement and hedge in shallow soil
New Brighton	SJ2665	SJ26336546	16-May-11	Boyett, L. E.	3	N. side of A494, between tarmac pavement and hedge in shallow soil
Alltami	SJ2766	SJ27426620	05-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27406619	05-Jul-10	Boyett, L. E.	2	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27396618	05-Jul-10	Boyett, L. E.	4	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27386617	05-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27376617	05-Jul-10	Boyett, L. E.	2	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27366615	05-Jul-10	Boyett, L. E.	4	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27356614	05-Jul-10	Boyett, L. E.	3	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27576623	05-Jul-10	Boyett, L. E.	31	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27586623	05-Jul-10	Boyett, L. E.	2	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27606623	22-Jul-10	Boyett, L. E.	9	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27616623	22-Jul-10	Boyett, L. E.	5	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27656624	22-Jul-10	Boyett, L. E.	3	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27686624	22-Jul-10	Boyett, L. E.	15	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27686625	22-Jul-10	Boyett, L. E.	10	S. facing, shallow soil bank between tarmac pavement and hedge

Alltami	SJ2766	SJ27696625	22-Jul-10	Boyett, L. E.	54	S. facing, shallow soil bank between tarmac pavement and hedge. Voucher specimen
Alltami	SJ2766	SJ27706625	22-Jul-10	Boyett, L. E.	9	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27716625	22-Jul-10	Boyett, L. E.	11	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27726625	22-Jul-10	Boyett, L. E.	29	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27736625	22-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27746625	22-Jul-10	Boyett, L. E.	19	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27756625	22-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27766625	22-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27816626	22-Jul-10	Boyett, L. E.	4	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami	SJ2766	SJ27876627	22-Jul-10	Boyett, L. E.	7	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami	SJ2766	SJ27886627	22-Jul-10	Boyett, L. E.	2	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami	SJ2766	SJ27896627	22-Jul-10	Boyett, L. E.	3	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami	SJ2766	SJ27906627	22-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami	SJ2766	SJ27946628	22-Jul-10	Boyett, L. E.	1	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami	SJ2766	SJ27966629	22-Jul-10	Boyett, L. E.	2	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami	SJ2766	SJ27606625	16-May-11	Boyett, L. E.	3	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2766	SJ27686625	16-May-11	Boyett, L. E.	10	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2766	SJ27696625	16-May-11	Boyett, L. E.	6	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2766	SJ27796626	16-May-11	Boyett, L. E.	4	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632. Voucher specimen
Alltami	SJ2766	SJ27706625	16-May-11	Boyett, L. E.	20	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2766	SJ27746625	16-May-11	Boyett, L. E.	7	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2766	SJ27716625	16-May-11	Boyett, L. E.	4	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2765	SJ27806626	16-May-11	Boyett, L. E.	1	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632. Voucher specimen
Alltami	SJ2766	SJ27816626	16-May-11	Boyett, L. E.	2	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Alltami	SJ2766	SJ27926628	16-May-11	Boyett, L. E.	3	N. side of A494, between tarmac pav.+ hedge in shallow soil, SJ27686625-SJ28086632
Chirk Kronospan Factory	SJ2838	SJ28963899	24-Jun-10	Boyett, L. E.	1	Paved forecourt of manweb substation, 50m from B5070, south facing
Chirk Kronospan Factory	SJ2838	SJ28983867	22-May-10	Boyett, L. E.	1	Voucher specimen
Chirk Kronospan Factory	SJ2838	SJ28963899	06-May-11	Boyett, L. E.	2	Crogen Rd, between hedge and tarmac pavement. Voucher specimen
Chirk North	SJ2839	SJ28933901	06-May-11	Boyett, L. E.	3	Turning to Wern Rd, off Crogen Rd, base of lampost, brick wall and tarmac pavement
Chirk North	SJ2839	SJ28923923	06-May-11	Boyett, L. E.	1	East side of B5070, between wall and tarmac pavement
Chirk North	SJ2839	SJ28923939	06-May-11	Boyett, L. E.	7	East side of B5070, between wall and tarmac pavement. Voucher specimen
Chirk North	SJ2839	SJ28923936	06-May-11	Boyett, L. E.	3	East side of B5070, between wall and tarmac pavement
Pentre	SJ2840	SJ28494064	23-Jun-10	Boyett, L. E.	1	In joint of south-west facing sandstone wall
Pentre	SJ2840	SJ28494062	23-Jun-10	Boyett, L. E.	1	In joint of south-east facing sandstone wall, 200m south-west of canal bridge. Voucher specimen
Pentre	SJ2840	SJ28484061	23-Jun-10	Boyett, L. E.	2	300mm up south-east facing wall, 240m south-west of canal. At foot of hedge
Pentre	SJ2840	SJ28454054	23-Jun-10	Boyett, L. E.	1	Back of footpath at field entrance. Open to sun, east of A5 junction

Pentre	SJ2840	SJ28824088	23-Jun-10	Boyett, L. E.	3	Ground level at back of tarmac pavement at foot of S. facing sandstone wall
Pentre	SJ2840	SJ28794086	23-Jun-10	Boyett, L. E.	1	Ground level at back of tarmac pavement at foot of S. facing sandstone wall
Pentre	SJ2840	SJ28634078	23-Jun-10	Boyett, L. E.	1	On railway bridge, south facing, between pavement and sandstone wall
Pentre	SJ2840	SJ28614078	23-Jun-10	Boyett, L. E.	1	20m west of railway bridge
Pentre	SJ2840	SJ28614077	23-Jun-10	Boyett, L. E.	1	In loose joint of wall, east of access to canal
Pentre	SJ2840	SJ28604077	23-Jun-10	Boyett, L. E.	1	E. end of canal bridge, ground level, corner of parapit wall and pavement, S. facing
Pentre	SJ2840	SJ28584076	23-Jun-10	Boyett, L. E.	2	Foot of lampost, 10m west of canal bridge, Voucher specimen
Pentre	SJ2840	SJ28564075	23-Jun-10	Boyett, L. E.	1	Edge of pavement and sandstone wall/hedge, 40m west of canal bridge, SW. Facing
Pentre	SJ2840	SJ28504028	23-Jun-10	Boyett, L. E.	6	Out of sandstone wall, SSW facing, 20-40mm up the wall, mixed hedge top
Pentre	SJ2840	SJ28504027	23-Jun-10	Boyett, L. E.	4	Out of sandstone wall, SSW facing, mixed hedge top
Pentre	SJ2840	SJ28514027	23-Jun-10	Boyett, L. E.	1	SSW facing, growing out through hedge
Pentre	SJ2840	SJ28494062	06-May-11	Boyett, L. E.	1	North west side of B5605
Pentre	SJ2840	SJ28654079	06-May-11	Boyett, L. E.	1	Against wall in turning from B5605 to Pentre village
Pentre	SJ2840	SJ28714082	06-May-11	Boyett, L. E.	1	In bus stop on S.E side of the B5605. Voucher specimen
Alltami, Mold Road	SJ2866	SJ28514027	22-Jul-10	Boyett, L. E.	4	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami, Mold Road	SJ2866	SJ28026630	22-Jul-10	Boyett, L. E.	6	S. facing, shallow soil bank between tarmac pavement and hedge, rusty disease
Alltami, Mold Road	SJ2866	SJ28036630	22-Jul-10	Boyett, L. E.	4	S. facing, shallow soil bank between tarmac pavement and hedge
Alltami, Mold Road	SJ2866	SJ28046629	16-May-11	Boyett, L. E.	4	N. side of A494, many plants SJ27686625-SJ28086640
Alltami, Mold Road	SJ2866	SJ28006630	16-May-11	Boyett, L. E.	1	N. side of A494, many plants SJ27686625-SJ28086640. Voucher specimen
Alltami, Mold Road	SJ2866	SJ28006629	16-May-11	Boyett, L. E.	11	N. side of A494, many plants SJ27686625-SJ28086640. Voucher specimen
Alltami, Mold Road	SJ2866	SJ28046630	16-May-11	Boyett, L. E.	4	N. side of A494, many plants SJ27686625-SJ28086640
Alltami, Mold Road	SJ2866	SJ28026630	16-May-11	Boyett, L. E.	8	N. side of A494, many plants SJ27686625-SJ28086640
Alltami, Mold Road	SJ2866	SJ28086631	16-May-11	Boyett, L. E.	8	N. side of A494, many plants SJ27686625-SJ28086640
Alltami, Mold Road	SJ2866	SJ28016630	16-May-11	Boyett, L. E.	3	N. side of A494, many plants SJ27686625-SJ28086640
Chirk	SJ2939	SJ29033808	06-May-11	Boyett, L. E.	1	West side of B5070. Voucher specimen

Appendix B

The IUCN criteria for Critically Endangered, Endangered and Vulnerable species

Appendix B - The IUCN criteria for Critically Endangered, Endangered and Vulnerable species

IUCN. (2001). **IUCN Red List Categories and Criteria: Version 3.1.** Gland, Switzerland and Cambridge, UK: IUCN Species Survival Commission.

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a–c:
   a. Severely fragmented or known to exist at only a single location.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a–c:
   a. Severely fragmented or known to exist at only a single location.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations

(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence

(ii) area of occupancy

(iii) number of locations or subpopulations

(iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
   a. structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 50 mature individuals, OR
      (ii) at least 90% of mature individuals in one subpopulation.
   b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes

may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at no more than five locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at no more than five locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.

c. Extreme fluctuations in any of the following:
   (i) extent of occurrence
   (ii) area of occupancy
   (iii) number of locations or subpopulations
   (iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
   a. Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 250 mature individuals, OR
      (ii) at least 95% of mature individuals in one subpopulation.
   b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
   (a) direct observation
   (b) an index of abundance appropriate to the taxon
   (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   (d) actual or potential levels of exploitation
   (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a–c:
   a. Severely fragmented or known to exist at no more than 10 locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a–c:
   a. Severely fragmented or known to exist at no more than 10 locations.
   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.
   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
   a. Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
      (ii) all mature individuals are in one subpopulation.
   b. Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

Appendix C

Isotype specimen for *Senecio cambrensis*

Appendix C – Isotype specimen for *Senecio cambrensis*

ISOTYPE
PE 169-96-50
Ex Herbarium of the Manchester Museum Isotype
Senecio cambrensis Rosser sp. nov.
Watsonia Vol. 3. p. 228-232
Loc. Roadside near Ffrith, Flintshire
v.-c. 51
Associated Plants Senecio vulgaris
Coll. L.W. Frost & E.M. Rosser Date 2/10/54 Reg. No.
55.484.1
Specimen treated with a chemical application
CARE!
Specimen very badly broken & very brittle

Figure 1: Isotype specimen for *Senecio cambrensis* Rosser. from the Museum of Wales Cardiff Herbarium.

Appendix D

Site descriptions

Appendix D - Site descriptions

New Brighton (SJ2665)

At New Brighton (SJ2665) *S. cambrensis* grows along a small section on the north side of the A494 (Littlewood Cottages). A small number of plants grow along the roadside in shallow soil between tarmac pavement and a hedge. Radiate and non-radiate *S. vulgaris* was also found along this section. *S. squalidus* was not present in the immediate area. The south side of the A494 at this section is overgrown with more competitive grass species and so would not make a suitable habitat for *S. cambrensis*.

Figure 2: *S. cambrensis* along the north side of the A494 (Littlewood Cottages).

Alltami (SJ2766) and Alltami, Mold Road (SJ2866)

The largest population of *S. cambrensis* in 2010 and 2011 were found at Alltami (SJ2766) and Alltami, Mold Road (SJ2866). Many individuals were found along the north side of the A494 (Mold Road) between SJ27686625 and SJ28086640. The plants were in shallow soil between a tarmac pavement and hedge with overhanging trees bringing shade along the verge. Along a section in Alltami, Mold Road (SJ2866) a small number of individuals were found between the tarmac pavement and a wall. Radiate and non-radiate *S. vulgaris* was also found along this section and *S. squalidus* was not present in the immediate area. The south side of the A494 is overgrown with more competitive grass species and would not make a suitable habitat for *S. cambrensis.* In 2010 many plants along this section had a disease with copper coloured spots on their leaves. In May 2011 this section of the verge had recently been mown, which made it very difficult to see and to identify individuals.

Figure 3: *S. cambrensis* with copper coloured disease on leaves in 2010 (SJ2787066270).

Pentre (SJ2840)

In 2010 27 individuals of *S. cambrensis* were found along the B5605 from Pentre towards Chirk and along the A5 from the junction with the B5605 towards Chirk. In this year along the B5605, all bar 1 individual were found on the north-western side of the road. These were mainly found at ground level between a sandstone wall with a hedge on top and a tarmac pavement. Some individuals grew out through the hedge from the top of the walls. The plants found along the A5 near the junction with the B5605 were found growing from a wall with a hedge on top, on the east side of the road. In 2011 only 3 individuals were found, one in shallow soil on the tarmac pavement at a bus stop, one between the road and a sandstone wall and one between tarmac pavement and sandstone wall. Non-radiate *S. vulgaris* was found along this section and *S. squalidus* was not present.

Figure 4: *S. cambrensis* in bus stop at Pentre on S.E side of the B5605

Chirk north (SJ2839)

In Chirk north (SJ2839) *S. cambrensis* was found at four different sites. Three of these were along the east side of the B5070 between tarmac pavement and a hedge. The other site where it was found was at the turning to Wern Rd, off Crogen Rd, at the base of a lamppost between a brick wall and tarmac pavement. Towards the roundabout for the B5070 and A5 a relatively new cycle path had been built and the verges were very grassy, providing an unsuitable habitat for *S. cambrensis* at this part of the road. Radiate and non-radiate *S. vulgaris* was also found along this section but *S. squalidus* was not present.

Figure 5: Cycle path and grassy verge near Chirk

Chirk, Kronospan Factory (SJ2838)

At Chirk, Kronospan Factory (SJ2838) *S. cambrensis* was only found at one site. This site was on the north side of Crogen Rd, between a hedge and tarmac pavement. There are many plants of non-radiate *S. vulgaris* in the area along the pavement and in gardens. *S. squalidus* was not present in the immediate area.

Llanddulas west, Clobryn Rd (SH8978)

At this site *S. cambrensis* was only found at one area. This was along the roadside on the north side of the A547 (Abergele Road) between Llysfaen Station Road and Clobryn Road. They were found in shallow soil between a tarmac pavement and wooden fence. Radiate and non-radiate *S. vulgaris* and *S. squalidus* was found along this section.

Figure 6: *S. cambrensis* at Llanddulas